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93-633

Final Report

Contract# W7714-8-5651/01-SV

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Title: "Development of a 15 GHz
Circular Polarization Selective Surface".

by

TIL-TEK Ltd.

Report written by:

D.A. Tilston

J. Towne

Senior Scientific Procurement Officer

Mark A. Beatty

Scientific Authority

Dr. G. A. Morin

D.R.E.O.

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1.0 Introduction

The objective of this project was to fabricate and test a circular polarization selective surface (CPSS) as described in the following paragraphs. The first such surfaces were designed, built and tested by Tilston, et al (1). These surfaces operated in the frequency range of roughly 1 - 2 GHz.

The specific purpose of this project was to fabricate and test a CPSS designed to operate at approximately 15 GHz. The work was carried out in three phases which will be described in subsequent chapters. The designs for test samples #1 and #2 were provided by Dr. Y.L. Chow (2). The design of test sample #3 was provided by Dr. G.A. Morin.

2.0 Materials, Equipment and Experimental Set-up

2.1 General

This chapter provides information on materials and equipment used, as well as experimental techniques.

2.2 Material

The material used in the fabrication of all surfaces tested is RT-Duroid 5870 from ROGERS CORP. This is a low-loss laminate with a relative dielectric constant of approximately 2.32. This material was chosen due to its low-loss characteristics and the fact that it is readily available in several different thicknesses and finishes. Refer to Appendix B for details on the properties of this material. Further information is available from ROGERS CORP.

2.3 Equipment

The same equipment was used in testing all surfaces. An equipment list is provided below:

Item	Description	Serial #
1	Wiltron 560A Scalar Network Analyzer	424014
2	Wiltron 6669A Programmable Sweep Generator	404009
3	Wiltron 560-98K50 SWR Autotester	83004
4	EIP 578 Microwave Frequency Counter	00466
5	AEL ASO-1601A LHCP Cavity Backed Spiral Antenna	088
6	AEL ASO-1601A LHCP Cavity Backed Spiral Antenna	089
7	AEL ASO-1601AA RHCP Cavity Backed Spiral Antenna	020
8	AEL ASO-1601AA RHCP Cavity Backed Spiral Antenna	021

Refer to Appendix B for detailed specifications for the equipment listed above.

2.4 Experimental Techniques and Set-up

This section describes the test set-up used for measurements and results for this project. Figure 2.1 illustrates the test set-up used for transmission tests. All support structures for antennas and the CPSS were built using wood and acrylic in order to keep interference from these structures to a minimum. The antennas and CPSS were positioned such that the CPSS would cover the entire half-power beamwidth of the antennas.

Transmission tests were performed at various angles of incidence by constructing dielectric support structures for the CPSS which would hold the surface at the required angle. These supports were not precision formed since the effect, as can be seen by the results, is minimal. These tests were performed for both left and right-hand circular polarization. In addition to measuring transmission loss through the CPSS, a sheet of plain dielectric and a metal plate were tested. These tests and the results are described in chapter 4.

Accurate reflection tests were not possible since it was difficult to achieve good isolation between transmitting and receiving antennas. However, transmission tests indicated a reject band for a given polarization and reflection was checked and found to occur across approximately the same band.

In all tests cable lengths were kept to a minimum in order to avoid unnecessary losses which would result in a loss in dynamic range.

3.0 Fabrication Techniques

3.1 General

The fabrication and test of a 15 GHz CPSS was performed in three stages as mentioned earlier. Initially, a CPSS designed to operate at 7.5 GHz was built and tested. Subsequently, two different designs were built and tested at 15 GHz. Details of these tests are described in the following sections.

3.2 Fabrication of a 7.5 GHz CPSS: Test Sample #1

The purpose of this phase of the project was to conduct preliminary investigations on a CPSS based on a design provided by the Scientific Authority.

The design provided by the Scientific Authority consisted of a 12" x 12" array of resonant dipoles on a 1/4" substrate with a relative dielectric constant of 2.32. Figures 3.2.1 and 3.2.2 show the design of the surface. The material chosen was R/T Duroid 5870. The characteristics of this material are provided in the data sheet (see Appendix B). The important qualities of this material were: low loss, stable characteristics over a wide range of frequencies and availability. Furthermore, it was felt that a woven glass type material was unsuitable since these can

exhibit circular polarization selectivity. However, the R/T Duroid was available in a maximum thickness of 0.125". Budget and time constraints would not permit a custom order. Therefore, the CPSS was constructed on two separate sheets which were then fastened together with nylon screws and nuts. The dipoles on opposite sides of the substrate were connected together with wire "feed-throughs" (Refer to Figure 3.2.3 for construction details). While this was an acceptable method for manufacturing a single CPSS, it would not be realistic for larger quantities.

The CPSS circuit board was fabricated using standard CAD and photo tools.

The photo reduction process was done in several stages to produce the required line definition and dimensional accuracy. A rubylith was generated at 10x scale by computer tool and then reduced by 5x using standard photo reduction techniques. This produced a single pattern at 2x scale. Photo repetition was then used to generate the pattern 144 times (12 x 12). The pattern was then reduced 2x to get a 1x etching mask.

Both boards were coated with photosensitive UV material and exposed through the mask. They were then stripped in an etching tank leaving the copper pattern. An immersion tin process was used to coat the pattern.

Final machining included routing the board edges to size and drilling the locating holes for 6-32 unc nylon mounting hardware.

Due to an error in transferring the design provided by the Scientific Authority to an actual CPSS, a right-hand CPSS (RHCPSS) was fabricated rather than a left-hand CPSS (LHCPSS). However, since antennas were required for both senses of polarization, it was decided to proceed with the RHCPSS for this phase of the project and correct the error in the next phases. Results for RHCP and LHCP should be the same.

3.3 Fabrication of a 15.5 GHz LHCPSS : Test Sample # 2

The fabrication of test samples #2 and #3 were similar. Test sample #2 consisted of an array of 625 cells arranged in a square 25 x 25 cells. The design for this LHCPSS is shown in Figures 3.3.1 and 3.3.2.

3.4 Fabrication of a 15.5 GHz LHCPSS : Test Sample # 3

The design provided by the Scientific Authority consisted of 564 1/4" cells arranged in an square pattern, octagonal outline (see Fig. 3.4.1) on RT Duroid 5870.

The LHCPSS circuit board was fabricated using standard CAD and photo tools.

To produce the required line definition and dimensional accuracy the photo reduction process was done in several stages. A Rubylith was generated at 10x scale by computer tool and reduced 5x using standard reduction techniques. This left a single pattern at 2x scale. Photo repetition was then used to generate the overall pattern of 564 cells. The pattern was then reduced 2x to get the 1:1 etching mask.

Before the pattern could be etched the board had to be drilled for the plated-through holes. The holes were then "seeded" to accept electro deposited copper. After the copper was deposited, the board was coated with photosensitive UV material and exposed through the photo mask. It was then stripped in an etching tank leaving the copper pattern. An immersion tin process was used to coat the pattern.

Final machining included routing the board to size and drilling the locating holes for 6-32 UNC nylon mounting hardware. The CPSS was secured between two sheets of RT-Duroid as shown in Figure 3.4.2 with 6-32 UNC nylon screws and nuts.

4.0 Experimental Results

4.1 General

This section describes the results obtained from the various measurements. The transmission loss plots, etc. can be found at the end of this chapter.

4.2 Experimental Results for 7.5 GHz RHCPSS: Test Sample #1

Figure 4.2.1 - Figure 4.2.27 show the results obtained. The test set-up was described earlier.

Figure 4.2.1 to 4.2.4 show the measured return loss of the antennas used for transmission and reflection tests.

Figure 4.2.5 illustrates the cable loss. Cables were kept as short as possible in order to obtain maximum dynamic range for the required tests. The maximum cable loss was approximately 3 dB as can be seen from Figure 4.2.5.

Path loss between antennas is shown in Figure 4.2.6 - 4.2.8. Cable loss has been factored out of these measurements. The path loss between identical antennas was between 25 dB and 30 dB (Figure 4.4.6, 4.2.8) for both left-hand circular (LHC) and right-hand circular (RHC) polarization. This resulted in a dynamic range of 25 dB - 30 dB for subsequent transmission and reflection tests. Figure 4.2.7 shows the path loss between RHCP and LHCP antennas. The loss was 50 dB - 60 dB as would be expected.

The transmission and reflection characteristics of the LHCPSS are shown in Figure 4.2.9 - 4.2.27 inclusive. It should be noted that for all these measurements, cable loss and free space path loss have been eliminated. Therefore, all results were due solely to the effects of the LHCPSS. Cable and path losses were eliminated by setting up the two antennas in the test jig. A Wiltron network analyzer was used to sweep the frequency range. The received signal level was then used as a 0 dB reference level.

In order to have some type of reference against which to compare the effect of the LHCPSS, a metal plate having the same dimensions as the active area of the LHCPSS was constructed and tested. Figure 4.2.9 shows the transmission characteristics for

a 1/4 " thick sheet of RT Duroid 5870. Attenuation between LHCP antennas as a result of the metal plate being positioned between the antennas and normal to the signal path is shown in Figure 4.2.10. Attenuation was between 20 dB and 30 dB. The variation across the frequency band is most likely the result of different edge effects at different frequencies.

Transmission loss of a LHCP signal through the LHCPSS is shown in Figure 4.2.11 - 4.2.18 for various angles of the surface. (The angles refer to degrees off normal). For each angle of incidence there are two figures. The first displays the entire test band from 3.75 GHz to 15 GHz. The second shows the operational bandwidth of the surface in more detail. Thus odd numbered figures show the complete test band, while even numbered figures show the results over a narrower band.

The transmission loss was minimal at the design frequency (7.5 GHz) for all angles of incidence. Furthermore, the -3 dB bandwidth did not change appreciably. However, the transmission nulls at the edges of the passband were affected somewhat. The 3 dB bandwidth for normal incidence was approximately 2.95 GHz from 6.15 GHz to 9.1 GHz. The centre frequency was obtained as the geometric mean of the passband edges. This resulted in an actual centre frequency of 7.48 GHz for the passband which is in very close agreement with the design frequency of 7.5 GHz.

Transmission loss for RHCP signals is shown in Figure 4.2.19 - 4.2.27. Transmission loss through the metal plate (Figure 4.2.19) was similar to that for LHCP. The transmission characteristics through the LHCPSS for RHCP signals and various angles of incidence were somewhat unexpected. Firstly, the transmission loss peak did not occur at the design frequency, but rather at 8.25 GHz, some 10% high. Also the transmission loss peak was very sharp: the 10 dB loss bandwidth being 500 MHz. Finally, the loss peak frequency was shifted to a lower frequency as the LHCPSS was positioned at a greater angle from normal.

Based on the above results it would appear that a correction factor of approximately 10% would be required for future designs.

4.3 Experimental Results for a 15.5 GHz CPSS : Test Sample # 2

The results of the tests are shown in Figures 4.3.1 to 4.3.18. All tests were performed over the frequency range 7.5 GHz - 37.5 GHz. Additionally, the tests were also performed over a narrower frequency range 10 GHz - 20 GHz in order to allow a more detailed view of operation near the design frequency.

Figures 4.3.1-4.3.18 are arranged in pairs. The first figure (odd-numbered) represents the test results over the full frequency range while the second figure (even-numbered) shows the results over the reduced frequency range. Throughout the tests, the dynamic range was approximately 25-30 dB.

Figures 4.3.1 and 4.3.2 show transmission loss through a 1/8" sheet of RT Duroid 5870. This was done to show the effect of the dielectric material itself. This is useful when interpreting the results from the subsequent test of the LHCPSS. The irregularities seen are due to the finite size of the dielectric sheet and of the LHCPSS in the remaining tests.

Figures 4.3.3-4.3.10 show transmission loss for left-hand circularly polarized (LHCP) radiation for angles of incidence of 0^{o}, 15^{o}, 30^{o} and 45^{o}. It is clear that the LHCPSS rejects LHCP radiation. It appears that the operating frequency is slightly higher than expected. The 10 dB reject bandwidth for normal incidence (Figure 4.3.6) is approximately 1 GHz ranging from 15.2 GHz to 16.2 GHz. This indicates a centre frequency of about 15.7 GHz which is roughly 1.2% high. It is also apparent that the operational bandwidth is somewhat dependent on the angle of incidence (see Figs 4.3.3-4.3.10).

Figures 4.3.11-4.3.18 show the results for transmission loss for right-hand circularly polarized (RHCP) radiation for the same angles of incidence as in the previous tests. It is interesting to compare Figure 4.3.2 and Figure 4.3.12. It is obvious that many of the irregularities seen in Figure 4.3.12 are due to the dielectric itself & that the overall effect of the LHCPSS is minimal from 14 GHz to 20 GHz.

4.4 Experimental Results for a 15.5 GHz CPSS : Test Sample # 3

The results of the tests are shown in Figures 4.4.1 to 4.4.16. The test set-up and equipment have been described earlier. All tests were performed over the frequency range 7.5 GHz - 37.5 GHz. Additionally, the tests were also performed over a narrower frequency range 10 GHz - 20 GHz in order to allow a more detailed view of operation near the design frequency.

Figures 4.4.1-4.4.16 are arranged in pairs. The first figure (odd-numbered) represents the test results over the full frequency range while the second figure (even-numbered) shows the results over the reduced frequency range. Throughout the tests, the dynamic range is approximately 25-30 dB.

Figures 4.4.1-4.4.8 show transmission loss for left-hand circularly polarized (LHCP) radiation for angles of incidence of 0^{o}, 15^{o}, 30^{o} and 45^{o}. It is clear that the LHCPSS rejects LHCP radiation. It appears that the operating frequency is slightly higher than expected. The 10 dB reject bandwidth for normal incidence (Figure 4.4.2) is approximately 1 GHz ranging from 15.5 GHz to 16.5 GHz. This indicates a centre frequency of about 16 GHz which is roughly 3.2% high. It is also apparent that the operational bandwidth is somewhat dependent on the angle of incidence (see Figures 4.4.1-4.4.8).

Figures 4.4.9-4.4.16 show the results for transmission loss for right-hand circularly polarized (RHCP) radiation for the same angles of incidence as in the previous tests. It is interesting to compare Figure 4.3.2 & Figure 4.4.10. It is obvious that many of the irregularities seen in Figure 4.4.10 are due to the dielectric itself & that the overall effect of the LHCPSS is minimal from 14 GHz to 20 GHz with some attenuation below 14 GHz.

5.0 Summary

Two 15.5 GHz CPSS's were fabricated and tested. The two surfaces behaved similarly. More experimentation would need to be performed in order to resolve the discrepancies between the theoretical and actual operating frequency of both surfaces. However, it has been shown that either type of CPSS can be used to achieve similar results.

The technology used to produce the surfaces was adequate for the frequency used in this project. The limiting factor for higher frequency designs would be the diameter of the feed-through holes. There are problems in reducing the diameter below 0.015". First, drill bits would easily break which would significantly increase the labour and therefore the cost of producing the surface. Secondly, it would become very difficult to ensure that the plate-through process did not leave voids in the centre of the hole. This would be especially difficult to test for as well. A visual inspection could not discover a void. A d.c. connectivity test would be insufficient in that it would not distinguish between good plate-throughs and those with partial voids. A partial void would cause an impedance mis-match between the two sides of surface for the particular element concerned. Enough of these undetected partial voids could seriously degrade the performance of the surface.

Therefore, in order to produce surfaces at higher frequencies, we must either improve our current printed circuit technology, use an alternative technology to produce the existing designs or find an alternative design which would allow existing, cost effective technology to be used.

APPENDICES

Appendix A: Equipment List

Model#	Description	S/N
ASO-1601 A	LHCP Antenna	088
ASO-1601 A	LHCP Antenna	089
ASO-1601 AA	RHCP Antenna	020
ASO-1601 AA	RHCP Antenna	021
Wiltron 560A	Network Analyzer	0029639
Wiltron 6669A	10 MHz - 40 GHz Sweep Generator	404009
Wiltron 560-7K50	RF Detector	Illegible
Wiltron 560-98K50	SWR Autotester	83004
EIP 578	Microwave Counter	00466
HP 7470A	Plotter	2308A23411

Appendix B: Data Sheets and Specifications

RT/duroid®

Rogers Corporation Microwave Materials Division 100 S. Roosevelt Ave., Chandler, AZ 85226 602 961-1382

RT/duroid® 5870
Glass Microfiber Reinforced
Polytetrafluoroethylene Composite

RT/duroid® 5870 glass microfiber reinforced PTFE composite is designed for exacting stripline and microstrip circuit applications.

Glass reinforcing microfibers are randomly oriented to maximize benefits of fiber reinforcement in the directions most valuable to circuit producers and in the final circuit application.

The dielectric constant of RT/duroid 5870 laminates is uniform from panel to panel and is constant over a wide frequency range. Its low dissipation factor extends the usefulness of RT/duroid 5870 to X-band and above.

RT/duroid 5870 laminate is easily cut, sheared and machined to shape. It has excellent dimensional stability and is resistant to all solvents and reagents, hot or cold, normally used in etching printed circuits or in plating edges and holes.

Normally supplied as a laminate with electrodeposited copper of ⅛ to 2 ounces/ft.² on both sides, RT/duroid 5870 composites can also be clad with rolled copper foil for more critical electrical applications. Cladding with aluminum, copper or brass plate may also be specified.

When copper-clad, RT/duroid 5870 composite meets MIL-P-13949 Type GRN or Type GPN microwave material specifications.

When ordering RT/duroid 5870 laminates, it is important to specify dielectric thickness, tolerance, rolled or electrodeposited copper foil, and weight of copper foil required.

(See reverse for product data)

PROPERTY	TEST METHOD	CONDITION	UNITS[1]	DIRECTION	TYPICAL VALUE[2]	
Dielectric constant, ϵr	1MHz, MIL-P-13949G Appendix B	C 24/23/50	—	Z	2.35	
	10GHz, IPC-TM-650, 2.5.5.5	C 24/23/50	—	Z	2.33 ± 0.02 spec.	
Dissipation factor, tan δ	1MHz, MIL-P-13949G Appendix B	C 24/23/50	—	Z	0.0005	
	10GHz, IPC-TM-650, 2.5.5.5	C 24/23/50	—	Z	0.0012	
Volume resistivity	ASTM D257	C96/35/90	Mohm cm	Z	2×10^7	
Surface resistivity	ASTM D257	C96/35/90	Mohm	X,Y	3×10^8	
					Test at 23°C	Test at 100°C
Tensile modulus	ASTM D638	A	MPa (kpsi)	X	1300 (189)	490 (71)
				Y	1280 (185)	430 (63)
ultimate stress			MPa (kpsi)	X	50 (7.3)	34 (4.8)
				Y	42 (6.1)	34 (4.8)
ultimate strain			%	X	9.8	8.7
				Y	9.8	8.6
Compressive modulus	ASTM D695	A	MPa (kpsi)	X	1210 (176)	680 (99)
				Y	1360 (198)	860 (125)
				Z	830 (120)	520 (76)
ultimate stress			MPa (kpsi)	X	30 (4.4)	23 (3.4)
				Y	37 (5.3)	25 (3.7)
				Z	54 (7.8)	37 (5.3)
ultimate strain			%	X	4.0	4.3
				Y	3.3	3.3
				Z	8.7	8.5
Deformation under load	ASTM D621				Test at 50°C	Test at 150°C
		24 hr/14MPa (2 kpsi)	%	Z	0.6	1.0
		24 hr/8.3MPa(1.2 kpsi)	%	Z	0.2	1.0
Water absorption	ASTM D570	D 24/23				
Thickness = 0.8 mm (0.031 in.)			mg (%)		0.9 (0.02)	
Thickness = 1.6 mm (0.062 in.)			mg (%)		1.3 (0.015)	
Specific gravity	ASTM D792				2.2	
Heat distortion temperature	ASTM D648	1.82MPa(264 psi)	°C(°F)	X,Y	>260 (>500)	
Specific heat	Calculated		J/g/K(BTU/lb/°F)		0.96 (0.23)	
Thermal conductivity	Rogers TR2721		W/m/K(BTU in/ft²/hr/°F)	Z	0.28 (1.8)	
Thermal expansion	ASTM D3386 (10 K/min.)		mm/m	→	X	Y	Z
(Values given are total change from a base temperature of 35°C)		−100°C			−5.0	−5.5	−11.6
		15			−0.6	−0.9	− 4.0
		25			−0.3	−0.4	− 2.6
		75			0.7	0.9	7.5
		150			1.8	2.2	22.0
		250			3.4	4.0	58.9

[1] SI units given first with other frequently used units in parentheses.
[2] References: Internal TR's 1430, 2224, 2854. Tests were at 23°C unless otherwise noted. Typical values should not be used for specification limits.

The above information is not intended to and does not create any warranties, express or implied including any warranty of merchantability or fitness for a particular purpose. Use of RT/duroid microwave laminate in your particular application may yield different results.

RT/duroid® microwave laminate is a registered trademark of Rogers Corporation for its microwave materials.

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1847-078-10.0-WA

Revised 3/81
Supersedes 1/78

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Model ASO-1601A

Electrical Performance Specifications

Frequency:	2 - 40 GHz
Polarization:	LHCP
VSWR:	2.5:1, 2 to 18 GHz
	3.1:1, 18 to40 GHz
Beamwidth:	3 dBi
	$90^{\circ} \pm 20^{\circ}$ from 2 to 4 GHz
	$75^{\circ} \pm 15^{\circ}$ from 4 to 30 GHz
	$65^{\circ} \pm 15^{\circ}$ from 30 to 40 GHz
Axial Ratio:	1 dB nominal, 2 dB max.
Boresight:	From 2 to 25 GHz
	2 dB nominal, 4 dB max.
	From 25 to 40 GHz
Power:	1 watt CW
Input connector:	SMA

AMERICAN ELECTRONIC LABORATORIES, INC.

CERTIFICATE OF COMPLIANCE

It is hereby certified that all the articles, materials, products, equipment and services furnished pursuant to this order number

Louis Albert Associates, Inc. *and TIL-TEK LTD* P/O: 00951 ,

have been produced and assembled in accordance with all applicable specifications, drawings and other order requirements, as stated on the face of the acknowledgement.

Description:	Antenna	Antenna
P/N:	ASO-1601A	ASO-1601AA
S/N:	088, 089	020, 021

Quantity this shipment 2 EA. Release/Project No. 4938

AMERICAN ELECTRONIC LABORATORIES, INC.

By: 04/14/89

Greg Krieger
Quality Assurance Manager Date

A Subsidiary of AEL Industries, Inc.

305 Richardson Road, Lansdale, PA 19446 Telephone: 215-822-2929
TWX: 510-661-4976 CABLE: AMERLAB

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AEL 70Q

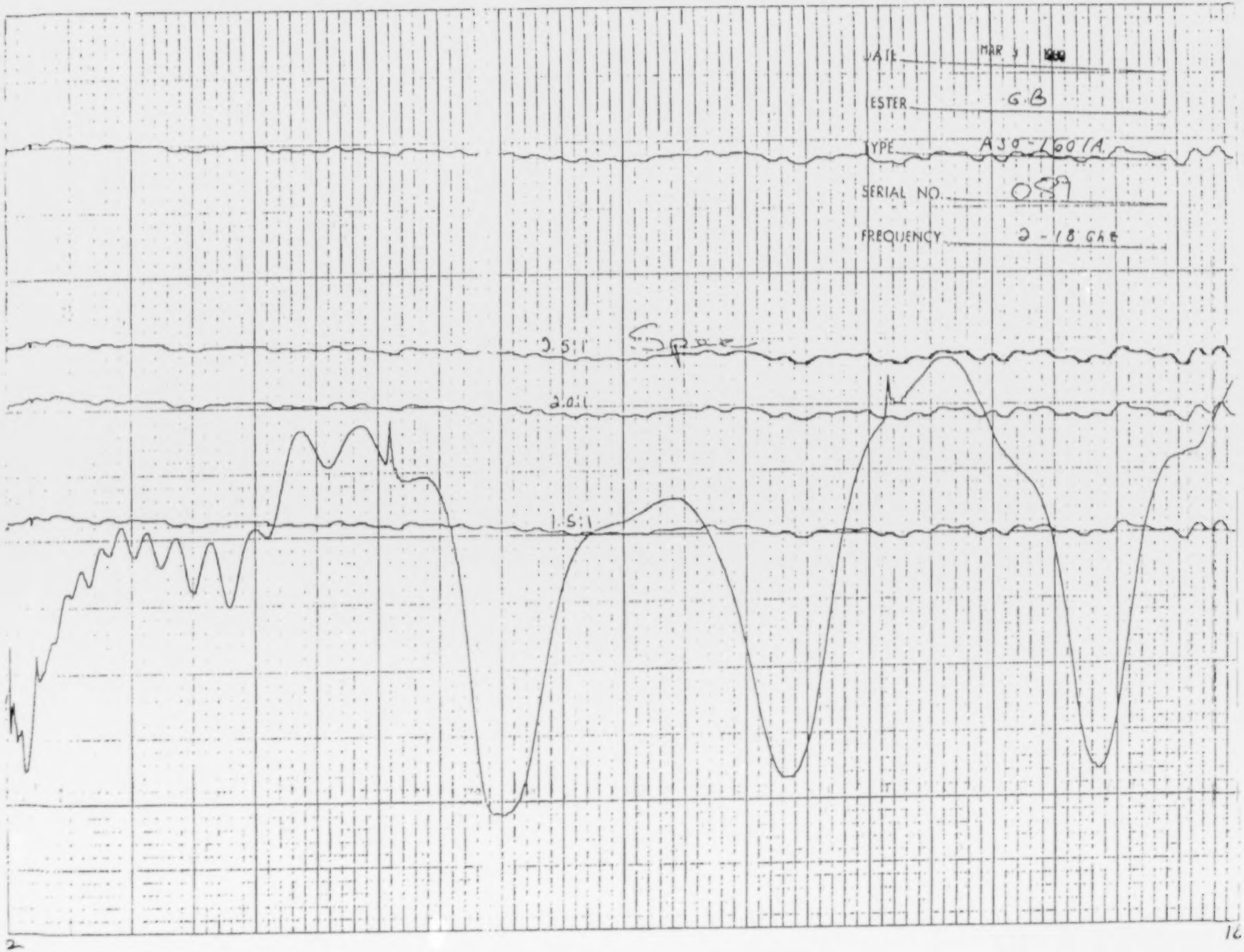
American Electronic Laboratories, Inc.
Subsidiary of AEL Industries, Inc.
305 Richardson Road, Lansdale, PA 19446, Telephone 215-822-2929 Telex 478-1188(AELABS) Cable AMERLAB

Date	
Project Number	
Tester	

SERIAL NUMBER: 088

ASO-1601A

FREQ. GHz.	SPEC.	READING
20.0	3.0:1	1.80:1
22.0	3.0:1	1.35:1
26.0	3.0:1	1.2:1
30.0	3.5:1	2.1:1
35.0	3.5:1	1.8:1
40.0	3.5:1	1.53:1



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American Electronic Laboratories, Inc.
Subsidiary of AEL Industries, Inc.
305 Richardson Road, Lansdale, PA 19446 Telephone: 215 822 2929 Telex: 475 1168 (AELABS) Cable: AMERLAB

AEL 700

Date	
Project Number	
Tester	

SERIAL NUMBER: 089

ASO-1601A

FREQ. GHz.	SPEC.	READING
20.0	3.0:1	1.3:1
22.0	3.0:1	1.75·1
26.0	3.0:1	1.28:1
30.0	3.5:1	2.5:1
35.0	3.5:1	1.53:1
40.0	3.5:1	1.8:1

3:1
2.5:1
2:1
1.5:1

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Date	
Project Number	
Tester	

SERIAL NUMBER: 021

ASC-1601AA

FREQ. GHz.	SPEC.	READING
20.0	3.0:1	1.12:1
22.0	3.0:1	1.26:1
26.0	3.0:1	1.28:1
30.0	3.5:1	1.4:1
35.0	3.5:1	1.12:1
40.0	3.5:1	2.1:1

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Date	
Project Number	
Tester	

SERIAL NUMBER: 020
ASO-1601AA

FREQ. GHz.		SPEC.		READING				
20.0		3.0:1		1.2:1				
22.0		3.0:1		1.1:1				
26.0		3.0:1		1.4:1				
30.0		3.5:1		1.65:1				
35.0		3.5:1		1.9:1				
40.0		3.5:1		2.8:1				

SPECIFICATIONS

The following paragraphs provide a description and specifications for the 560A Scalar Network Analyzer; 560-97, -98, and -6 series SWR Autotesters; and 560-7 and -71 series RF detectors.

1-4.1 Model 560A Scalar Network Analyzer

The Model 560A Scalar Network Analyzer is a GPIB-compatible, three-channel microwave measurement instrument. The three channels consist of two measurement channels (A, B) and one reference channel (R), which allow the network analyzer to simultaneously display the results of two measurements. The 560A also contains internal memory circuits that provide two different functions — measurement-normalization memory and display-refresh memory. The measurement-normalization memory stores transmission measurement system residuals and return loss calibration data. The display-refresh memory provides a non-flickering display, regardless of sweep generator sweep speed. The refresh memory also provides for a slow, 30-second sweep for an external X-Y plotter.

A complete listing of the 560A specifications is contained in Table 1-1.

Table 1-1. Model 560A Scalar Network Analyzer Specification Chart

FREQUENCY RANGE: See SWR Autotester and RF detector specifications, Table 1-2 and Table 1-3, respectively.

CHANNELS: Three (A, B, R) with pushbutton selection of A, B, R, A-R and B-R. Detected input signals supplied by detectors or SWR Autotester, which may be interchanged without adjustment. Two channels are displayed simultaneously.

DYNAMIC MEASUREMENT RANGE AND SENSITIVITY:
A and B with Detectors:*
71 dB (+16 dBm to −55 dBm)
A and B with SWR Autotester:
65 dB (+10 dBm to −55 dBm)**
R with Detector:*
+6 dB (+16 dBm to −30 dBm)

*With 75Ω detectors, maximum output is +13 dBm.

**As seen by internal detector, typically 13 dB below input power with 0 dB return loss at test port.

OFFSET CONTROL: Positioning of A and B traces is independently and continuously adjustable over > ±65 dB range. When trace is on reference line, power is displayed in dBm on 3-digit LED readout with 0.1 resolution. Offset is displayed in dB relative to a 0 dB reference level or in dBm relative to a 0 dBm reference level.

ZERO dB REFERENCE SET: Positions reference trace at selected 0 dB reference line.

REFERENCE POSITION LOCATOR: Displays reference trace to locate reference line. Position of reference line screwdriver-adjusted.

OFFSET ZERO POSITION: Moves trace to the position it would have if OFFSET were adjusted to 0 dB.

RESOLUTION: Independent control for A and B in steps of 0.2, 0.5, 1, 2, 5, 10 dB per division. Other values (3, 6, 15 dB, etc.) obtained by depressing multiple pushbuttons.

MEMORY:

STORE TRACE: Stores displayed trace(s) in 1024-point memory. Used to store system residuals and the average of open/short reflections for subtraction from input test data.

AVERAGE: Averages data in memory with input test data and displays the result. Used to average system open/short return loss characteristics for subtraction from input test data.

SUBTRACTION: Subtracts data in memory from input test data and displays result.

RECALL: Displays stored data.

UNCALIBRATED SWEEP INDICATOR: Lights when external sweep generator sweep rate is too fast for memory.

DISPLAY MODES:

REAL TIME: Horizontal sweep is synchronized with ramp from external sweep generator.

REFRESH: External sweep generator ramp is digitized and stored in 1024-point memory (512 points for dual trace). Stored data is updated continuously at sweep generator sweep rate. Steady, nonflickering display is provided regardless of sweep generator sweep rate. Vertical resolution is 512 points for single or dual traces.

REFRESH HOLD: Updating of display data is stopped. Display is frozen.

X-Y PLOT (REAL TIME): Provides pen lift, vertical, and horizontal signals for X-Y plot. Dual traces are automatically recorded by sweeping A and B channels sequentially.

X-Y PLOT (REFRESH): Display is frozen and then plotted at 30-second sweep rate. Dual traces are automatically recorded by sweeping A and B channels sequentially. After 1 second, sweep may be aborted and returned to start.

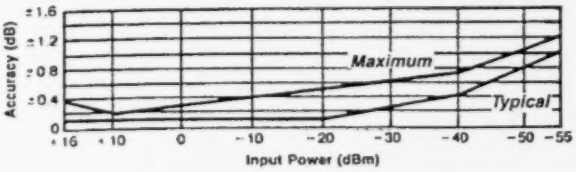
SMOOTHING FILTERS: Three levels of filtering optimize low-level signal displays.

Table 1-1. Model 560A Scalar Network Analyzer Specification Chart (continued)

MARKERS: Threshold and tilt control of externally-applied birdie or video markers.

ACCURACY

A AND B CHANNEL ACCURACY:
±0.2 dB at +10 dBm, decreasing at a rate of 0.1 dB per each 10 dB increment to ±0.7 dB at −40 dBm, to ±1.0 dB at −50 dBm, and to ±1.2 dB at −55 dBm.



OVERALL RETURN LOSS MEASUREMENT ACCURACY: Uncertainties resulting from SWR Autotester and sweep generator frequency response and system open/short characteristics are subtracted automatically from test data. Overall accuracy is then:

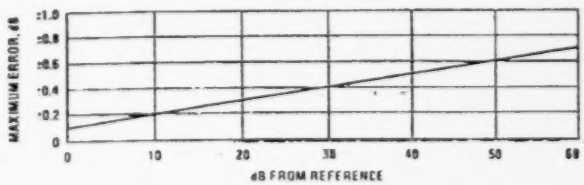
SWR Autotester Accuracy (Table 1-2)
+
A and B Channel Accuracy (above)

OVERALL TRANSMISSION LOSS/GAIN MEASUREMENT ACCURACY: Uncertainties resulting from frequency response of detectors, SWR Autotester, sweep generator and other test system components are subtracted automatically from test data. Overall accuracy is then:

A and B Channel Accuracy*

* Effects of sweep generator, test device, and detector mismatch may be significant. Mismatch errors are either minimized by the exceptional low reflection characteristics of the 560 detectors (see detector return loss specifications) or padded by the insertion loss of the SWR Autotester (paragraph 1-4.2).

RATIO MEASUREMENT ACCURACY (A-R, B-R):



Above curve includes all log amplifier uncertainties. Errors due to Detector Mismatch variations must be accounted for separately. The use of memory eliminates errors due to detector frequency variations.

OVERALL ABSOLUTE POWER MEASUREMENT ACCURACY:
Absolute power measurement accuracy is determined by the frequency response accuracy of the detector and the absolute accuracy of the log amplifier. Absolute power accuracy is then:

Detector Frequency Response Accuracy (Table 1-3)
+
A and B Channel Accuracy (above)

CRT DISPLAY

CATHODE RAY TUBE (CRT): 8 vertical by 10 horizontal divisions. One division = 1.22 cm. Single beam, standard persistence (P31) phosphor CRT with internal graticule.

CRT BEAM CONTROLS: Intensity, Focus, Trace Rotation, and Horizontal Position.

CAMERA: Compatible with Tektronix C5A, B, or C model camera.

HOOD: Compatible with Tektronix 016-0260-00 Hood.

INPUT CONNECTIONS

HORIZONTAL INPUT: HORIZONTAL SELECT switch selects one of three types of sweep ramp inputs at rear panel HORIZONTAL INPUT connector: 0 to +10V, 0 to +15V, and −8 to +8V. BNC connector, 100k ohms input impedance.

MARKER INPUT: 1mV to 10V peak input, rear panel BNC connector, 100k ohms input impedance. In addition, a −3V to −10V input to Z AXIS rear panel connector provides markers.

Z AXIS INPUT: +3 to +10V blanks and maintains trace amplitude during switching of sweep generator oscillators. −3V to −10V introduces markers which are controlled by THRESHOLD and TILT. Rear panel BNC connector, 10k ohms input impedance.

OUTPUT CONNECTIONS

RECORDER/CRT MONITOR CONTROL: Rear Panel OUTPUT MODE switch selects appropriate horizontal, vertical, blanking, and pen lift output voltages for external CRT monitor or mechanical recorder.

HORIZONTAL SWEEP RAMP OUTPUT: 0 to 10V in synchronism with sweep display. Rear panel BNC connector.

VERTICAL OUTPUT: Varies from 0 to ±8V (1V/div.) in proportion to display trace position. When OUTPUT MODE switch is in CRT position, voltage alternates between A and B. When the switch is in RCDR position and an X−Y plot is initiated, voltage first varies in proportion to A over full swept range and then in proportion to B. Pen-lift voltage lifts recorder pen between sweeps. Rear panel BNC connector.

BLANK/PEN LIFT OUTPUT: Provides either CRT

Table 1-1. Model 560A Scalar Network Analyzer Specification Chart (continued)

blanking output or pen lift control signal, depending upon the position of the OUTPUT MODE switch. In the CRT mode, the positive TTL-compatible voltage is HIGH during retrace and LOW during forward sweep. In the RCDR mode, the pen lift relay contacts are normally-open during retrace. Lifted pen is held off paper until new sweep is started. Internal jumper is available for normally-closed contacts. Rear panel BNC connector.

ALTERNATING SWEEP INPUT/OUTPUT

AUX I/O: Provides interconnection between compatible sweep generators, such as the WILTRON 6600A Series Programmable Sweep Generator, and the 560A. Eliminates rear panel BNC connections between the compatible sweep generator and the 560A.

GPIB

DIGITAL INTERFACE: Conforms to IEEE 488 and IEC 625 standard digital interface for programmable instrumentation. Function subsets implemented: SH1, AH1, T6, TE0, L4, LE0, SR1, RL2, PP0, DC1, and DT0.

GPIB ADDRESS: TALK and LISTEN addresses selected by rear panel switches.

DATA DELIMITER: Rear panel switch selects either CARRIAGE return (CR) or CARRIAGE RETURN and LINE FEED (CR/LF) as data delimiters when in the TALK mode.

SRQ: Instrument can be programmed to generate a service request (SRQ) when data is available. If SRQ implementation is not desired, handshake will be completed when data is available.

REMOTE INDICATOR: Lights when test set is operating on GPIB.

PHYSICAL

TEMPERATURE RANGE:
Operating: 0°C to +50°C
Storage: -40°C to +70°C

POWER: 100V/120V/220V/240V +5%, -10% selectable on rear panel. 44-66 Hz, 85VA maximum.

WEIGHT:
560A Horizontal or 560A Option 2 Vertical Configuration: 11 kg (24.5 lb)
560A Option 1 Rack Mounting: 13.5 kg (30 lb)

SIZE:
560A Horizontal Configuration
133 mm H x 429 mm W x 500 mm D
(5.26 x 16.9 x 19.7 in)
560A Option 2 Vertical Configuration
267 mm H x 213 mm W x 500 mm D
(10.5 x 8.4 x 19.7 in)
560A Option 1 Rack Mount
133 mm H x 483 mm W x 500 mm D
(5.25 x 19 x 19.7 in)

RACK MOUNTING (OPTION 1): Units supplied with mounting ears and chassis track slide (90° tilt) installed.

VERTICAL CONFIGURATION (OPTION 2): Unit supplied with CRT chassis mounted atop the network analyzer chassis (Figure 1-1).

GPIB PROGRAMMABILITY (OPTION 3): Unit supplied with IEEE 488 (IEC 625) BUS (GPIB) Interface.

DC FAN (OPTION 4): Unit supplied with a DC Fan allowing 50-400 Hz operation.

1-4.2 Model 560 SWR Autotesters

The Model 560-97, -98, and -6 series SWR Autotesters are broadband, high-directivity reflection bridges with a built-in detector and a low-reflection test port. These SWR Autotesters are specifically designed to be compatible with all three channels of the 560A Scalar Network Analyzer. These 560 Model SWR Autotesters are well suited to making very accurate return loss (SWR) measurements. With their typical 6.5 dB insertion loss, these components provide a pad between the source and the device under test. Padding of the sweep generator output results in a more accurate transmission loss/gain measurement because it reduces the effect of the impedance mismatch at the source.

A listing of the Model 560-97, -98, and -6 series SWR Autotester specifications is presented in Table 1-2.

Table 1-2. SWR Autotester Specifications

MODEL	TEST PORT CONNECTOR	INPUT CONNECTOR	DIRECTIVITY	ACCURACY ① 10 MHz to 8 GHz	ACCURACY ① 8 GHz to 18 GHz	INPUT Z	FREQUENCY SENSITIVITY	PHYSICAL
560-97A50	GPC-7	N Female	36 dB $\pm 0.06\rho^2$	0.016 $\pm 0.1\rho^2$	0.016	50Ω	±2.0 dB (max)	Length: 7.6 cm (3 in.) Width: 5 cm (2 in.) Depth: 2.8 cm (1-1/8 in.) Weight: 425 g (15 oz.)
Option 1			40 dB	0.01 $\pm 0.06\rho^2$	0.01 $\pm 0.1\rho^2$			
560-97N50 560-97NF50	N Male Female	N Female	35 dB	0.018 $\pm 0.08\rho^2$	0.018 $\pm 0.12\rho^2$			
Option 1			38 dB	0.013 $\pm 0.08\rho^2$	0.018 $\pm 0.12\rho^2$			
				10 MHz to 18 GHz	18 GHz to 26.5 GHz			
560-98S50	Male	WSMA Female	35 dB (.01-18 GHz)			50 Ω	±1.0 dB	
560-98SF50	WSMA Female		32 dB (18-26.5 GHz)	0.018 $\pm 0.1\rho^2$	0.025 $\pm 0.12\rho^2$		±2.0 dB	Length: 5.3 cm (2-3/32 in.) Width: 3.7 cm (1-15/32 in.) Depth: 1.2 cm (15/32 in.) Weight: 198 g (7 oz.)
			38 dB (.01-18 GHz				±1.0 dB	
Option 1			35 dB (18-26.5 GHz)	0.013 $\pm 0.1\rho^2$	0.018 $\pm 0.12\rho^2$		±2.0 dB	
				10 MHz to 26.5 GHz	26.5 GHz to 40.0 GHz			
560-98K50 560-98KF50	K Male, Female	K Female	35 dB	0.018 $\pm 0.15\rho^2$	0.032 $\pm 0.18\rho^2$	50 Ω	±3.0 dB	Length: 3.8 cm (2-1/8 in.) Width: 2.9 cm (1-1/2 in.) Depth: 1.9 cm (3/4 in.) Weight: 198 g (7 oz.)
				1 MHz to 2000 MHz				
560-6N50 560-6NF50	N Male Female		40 dB	0.01 $\pm 0.06\rho^2$		50 Ω	±1.0 dB (max.)	Length: 3.8 cm (1-1/2 in.) Width: 2.9 cm (1-5/32 in.) Depth: 3 cm (1-3/16 in.) Weight: 227 g (8 oz.)
560-6N75 ② 560-6NF50 ②	N Male Female		40 dB	0.01 $\pm 0.06\rho^2$		75 Ω		
All Models								
Insertion Loss: 6.5 dB ③ nominal; Cable Length: 122 cm (4 ft.); Maximum Input Power: 27 dBm								

① Where ρ is measured reflection coefficient of test device. Accuracy includes effects of test port reflections and directivity.
② 75 ohm impedance.
③ From RF input port to test port.

1-4.3 Model 560 RF Detectors

The Model 560-7 and 560-71 series RF detectors are specifically designed to be used interchangeably between Channel A, B, and R without need for adjustment. Both detector models are equipped with a specially-designed zero-bias Schottky diode that provides -55 dBm sensitivity. In the 560-7 series detectors, this diode is encased in a field-replaceable module; in the 560-71 series detectors this diode is a discrete component, and is also field replaceable. The 560-7K50 is not field replaceable.

A listing of the 560-7 and 560-71 series RF detector specifications is provided in Table 1-3.

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Table 1-3. RF Detector Specifications

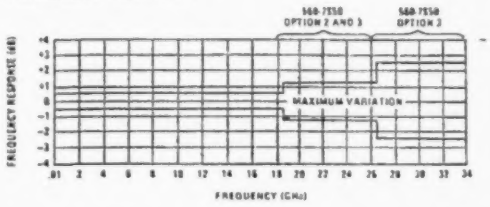
Model 560-	Input Connector	Input Z	Frequency
7A50	GPC-7	50Ω	10 MHz to 18.5 GHz
7N50	Type N Male	50Ω	10 MHz to 18.5 GHz
7S50 Option 1	WSMA Male	50Ω	10 MHz to 18.5 GHz
7S50 Option 2	WSMA Male	50Ω	10 MHz to 26.5 GHz
7S50 Option 3	WSMA Male	50Ω	10 MHz to 34.0 GHz
7K50	K Male	50Ω	10 MHz to 40.0 GHz
71N50	Type N Male	50Ω	1.0 MHz to 2.0 GHz
71N75	Type N Male	75Ω	1.0 MHz to 2.0 GHz

All Models

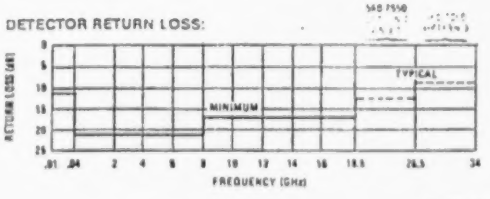
Maximum Input Power: 20 dBm (100 mW)
Cable Length: 122 cm (4 ft.)
Dimensions: 7.6 x 2.9 x 2.2 cm (3 x 1-1/8 x 7/8 in.)
Weight: 170 grams (6 oz.)

560-7 Series

FREQUENCY RESPONSE:

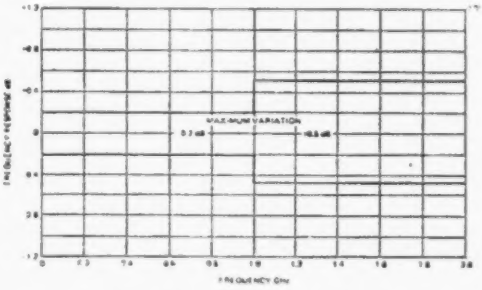


DETECTOR RETURN LOSS:

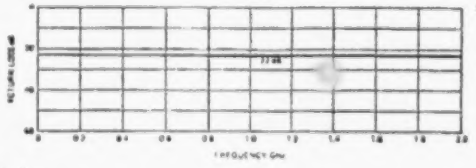


560-71 Series

FREQUENCY RESPONSE:

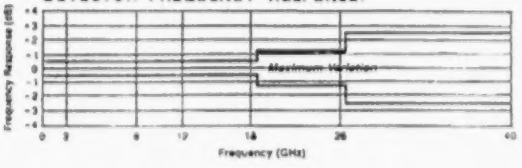


DETECTOR RETURN LOSS:



560-7K Series

DETECTOR FREQUENCY RESPONSE:



DETECTOR RETURN LOSS:

SPECIFICATIONS, ALL MODELS

EXTERNAL AM INPUT: Rear panel BNC connector. 10k ohm impedance.
Sensitivity: 1 dB/V
Frequency Response (typical): DC–50 kHz
Input Impedance: 10 kΩ
Amplitude Control Range: >13 dB
Maximum Input: 20V

EXTERNAL FM AND PHASE LOCK INPUT: Rear panel BNC connector. 10k ohm impedance.
Sensitivity: –5 MHz/V
Maximum Deviation for Modulation Frequency of:
DC–100 kHz: ±25 MHz
100–250 kHz: ±5 MHz

EXTERNAL SQUARE WAVE INPUT: Externally applied TTL-compatible square wave modulates output at dc to 50 kHz rate. Will accommodate ±6V square wave. On/Off ratio, typically 40 dB. Maximum input, ±20 volts. Rear panel BNC connector.

POWER VARIATION WITH TEMPERATURE: ±0.5 dB/°C.

RESIDUAL AM (50 kHz Bandwidth): >50 dBc.

OUTPUT CONNECTOR: Type N Female.
6653A/6659A: Ruggedized K Female
6654A/6663A/6669A: Ruggedized K Female
6662A/6665A: Ruggedized WSMA Female, <26.5 GHz
UG-599/U Waveguide, >26.5 GHz

INPUT POWER: 100, 115–120 Vac (+5%, –10%) at 2.0A rms or 220, 230–240 Vac (+5%, –10%) at 1.0A rms, 44–66 Hertz.

OPERATING TEMPERATURE RANGE: 0 to 50 degrees centigrade.

PHYSICAL:
Height: 13.34 cm (5.25 inches)
Width: 43.18 cm (17 inches)
Depth: 47.6 cm (18.75 inches)

FREQUENCY, POWER, AND PURITY SPECIFICATIONS, INDIVIDUAL MODELS

MODEL	FREQUENCY RANGE (GHz)	OUTPUT POWER (25°C ±5°)		POWER LEVEL ACCURACY			LEVELED POWER VARIATION		SIGNAL PURITY			FREQUENCY ACCURACY (25°C)		FREQUENCY STABILITY					SOURCE SWR		WT (kg) (lb)
		INTERNALLY LEVELED MAXIMUM (dBm)	WITH OPT. 2, 70 dB ATTENUATOR (dBm)	LEVELED (dB)	WITH OPT. 2, 70 dB ATTENUATOR, ADD: (dB)	ATTENUATOR ACCURACY PER STEP (dB)	WITH FREQUENCY (dB)	WITH FREQUENCY OPT. 2, 70 dB ATTENUATOR (dB)	HARMONICS (dBc)	NON-HARMONICS (dBc)	RESIDUAL FM [3] (kHz pk)	CW MODE (MHz)	SWEEP MODE ≤ 50 MHz (MHz)	WITH TEMPERATURE (MHz/°C)	WITH 10% LINE VOLTAGE CHANGE (kHz)	WITH 10 dB POWER LEVEL CHANGE (kHz)	WITH 3:1 LOAD SWR (kHz)	WITH TIME, 10 MINUTES TYPICAL [4] (kHz)	STD MODEL	OPT 2 & 9	
6653A	2-26.5	>10 [≤18 GHz) >8 [>18 GHz]	>7 [≤18 GHz) >3 [>18 GHz]	±1@2 GHz	±2	±0.7	±1.0	±1.5	>40	>50	<7 [<8 GHz] <10 [8-18 GHz] <15 [>18 GHz]	±20	±20	±1	±100	±500	±300	±700	1.5 [≤18 GHz] 1.7 [>18 GHz]	7.0	15.2 34.0
6654A	.01-26.5	>10 [≤18 GHz] >8 [>18 GHz]	>7 [≤18 GHz] >3 [>18 GHz]	±1@2 GHz	±2	±0.7	±1.0	±1.5	>30 [<2 GHz] >40 [>2 GHz]	>40 [≤2 GHz] >50 [>2 GHz]	<7 [<8 GHz] <10 [8-18 GHz] <15 [>18 GHz]	±20	±20	±.7 [<2 GHz] ±0.5 [>2 GHz]	±100	±300	±300	±700	1.5 [≤18 GHz] 1.7 [>18 GHz]	7.0	15.2 34.0
6660A	12.4-40	>8 [<26.5 GHz] >6 [<26.5 GHz]	N/A	±1@26 GHz	N/A	N/A	±1.0	N/A	>40 >30	>40	<10 [<18 GHz] <13[18-26.5 GHz] <20 [<26.5 GHz]	±20	±20	±1 [<26.5 GHz] ±2 [>26.5 GHz]	±100	±300 [<26.5 GHz] ±1000 [>26.5GHz]	±300	±700 [<26.5 GHz] ±400 [>26.5 GHz]	1.5 [≤18 GHz] 1.7 [18-26.5 GHz] 2.0 [26.5-40 GHz]	Opt 2 N/A Opt 9 7.0	15.9 36.0
6662A	2-40	>10 [<18 GHz] >8 [>18 GHz]	N/A	±1 @ 2 GHz N/A > 26.5 GHz	N/A	N/A	±1 [<26.5 GHz] N/A [>26.5 GHz]	N/A	>40 [<26.5 GHz] >30 [>26.5 GHz]	>40	<7[<8 GHz] <10[8-18 GHz] <13[18-26.5 GHz] <20 [>26.5 GHz]	±20	±20	±1 [<26.5 GHz] ±2 [>26.5 GHz]	±100	±300 [<26.5GHz] ±1000 [>26.5GHz]	±300	±700 [<26.5 GHz] ±400 [>26.5 GHz]	1.5 [≤18 GHz] 1.7 [18-26.5 GHz] N/A [>26.5 GHz]	Opt 2 N/A Opt 9 7.0	13.6 29.9
6663A	2-40	>8 [<26.5 GHz] >6 [>26.5 GHz]	N/A	±1@2 GHz	N/A	N/A	±1.5	N/A	>40 [<26.5 GHz] >30 [>26.5 GHz]	>40	<7[<8 GHz] <10[8-18 GHz] <13[18-26.5 GHz] <20[>26.5 GHz]	±20	±20	±1 [<26.5 GHz] ±2 [>26.5 GHz]	±100	±300 [<26.5GHz] ±1000 [>26.5GHz]	±300	±700 [<26.5 GHz] ±400 [>26.5 GHz]	1.5 [≤18 GHz] 1.7 [18-26.5 GHz] 2.0 [26.5-40 GHz]	Opt 2 N/A Opt 9 7.0	13.6 29.9
6668A	01-40	>10 [<18 GHz] >8 [>18 GHz]	N/A	±1 @ 2 GHz N/A > 26.5 GHz	N/A	N/A	±1 [<26.5 GHz] N/A [>26.5 GHz]	N/A	>30 [<2 GHz] >40 [2-26.5 GHz] >30 [>26.5 GHz]	>40 [≤2 GHz] >50 [>2 GHz]	<7 [<8 GHz] <10 [8-18 GHz] <13[18-26.5 GHz] <20 [>26.5 GHz]	±20	±20	±1 [<26.5 GHz] ±2 [>26.5 GHz]	±100	±300 [<26.5GHz] ±1000 [>26.5GHz]	±300	±700 [<26.5 GHz] ±400 [>26.5 GHz]	1.5 [≤18 GHz] 1.7 [18-26.5 GHz] N/A [>26.5 GHz]	Opt 2 N/A Opt 9 7.0	13.6 29.9
6669A	.01-40	>8 [<26.5 GHz] >6 [>26.5 GHz]	N/A	±1@2	N/A	N/A	±1.5	N/A	>30 [<2 GHz] >40 [2-26.5 GHz] >30 [>26.5 GHz]	>40 [≤2 GHz] >50 [>2 GHz]	<7 [<8 GHz] <10[8-18 GHz] <13[18-26.5 GHz] <20[>26.5 GHz]	±20	±20	±1 [<26.5 GHz] ±2 [>26.5 GHz]	±100	±300 [<26.5GHz] ±1000 [>26.5GHz]	±300	±700 [<26.5 GHz] ±400 [>26.5 GHz]	1.5 [≤18 GHz] 1.7 [18-26.5 GHz] 2.0 [26.5-40 GHz]	Opt 2 N/A Opt 9 7.0	13.6 29.9

[1] External leveling only.
[2] Excluding 5% band edges where specification is > 20 dBc.
[3] Measured in 20 Hz–15 kHz bandwidth.
[4] After 30 minutes warmup at selected CW frequency.

Figure 1-2. Specifications

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SPECIFICATIONS

EIP 578 MICROWAVE COUNTER

GENERAL	
RESOLUTION	Front panel keyboard input select 1 Hz to 1 GHz
MEASUREMENT TIME	1 msec for 1 KHz resolution 1 sec for 1 Hz resolution
DISPLAY	12 digit LED sectionalized
ACCURACY	±1 count ± time base errors
TEST	Front panel selected diagnostics
SAMPLE RATE	Controls time between measurements variable from 100 msec typ. to 10 sec. Switchable Hold position holds display indefinitely.
RESET	Resets display to zero and initiates new reading
OFFSETS	Keyboard control of frequency offsets (standard) and power offsets (standard with power measurement Option 02). Displayed frequency (power) is offset by entering value to 1 Hz resolution (0.1 dB power).
OPERATION TEMP.	0°C to 50°C
POWER	100/120/220/240/VAC ± 10% (selectable) 50 to 60 Hz, 60 VA typical
WEIGHT, NET	~20 lbs. (9.07 kg)
WEIGHT, SHIPPING	~25 lbs. (11.34 kg)
DIMENSIONS (HWD)	3.5" x 16.75" x 14.0" (89 mm X 425 mm X 356 mm)
ACCESSORIES FURNISHED	Power Cord and Manual

SPECIFICATIONS, continued

BAND 1	
RANGE	10 Hz to 100 MHz
SENSITIVITY	25 mV rms
IMPEDANCE	1 MΩ/20 pF
CONNECTOR	BNC (female)
MAX. INPUT LEVEL	120 V rms *
DAMAGE LEVEL	150 V rms *
	* (Above 1 KHz max. input will decrease at 6 dB/octave down to 3.0 V rms.)

BAND 2	
RANGE	10 MHz to 1 GHz
SENSITIVITY	-20 dBm
DYNAMIC RANGE	30 dB
IMPEDANCE	50Ω Nominal
CONNECTOR	BNC (female)
MAX. INPUT LEVEL	+10 dBm
DAMAGE LEVEL	+27 dBm
ACQUISITION TIME	< 50 msec

BAND 3	
RANGE	1 GHz to 18 GHz (26.5 GHz for model 548)
SENSITIVITY	−30 dBm: 1 GHz-12.4 GHz −25 dBm: 12.4 GHz-18 GHz −20 dBm: 18 GHz-22 GHz −15 dBm: 22 GHz-26.5 GHz
DYNAMIC RANGE	1 GHz to 12.4 GHz, 37 dB 12.4 GHz to 18 GHz, 32 dB 18 GHz to 22 GHz, 27 dB 22 GHz to 26.5 GHz, 22 dB
IMPEDANCE	50Ω Nominal
CONNECTOR	Model 575 - Precision type N, (female) Model 578 - SMA (female)
MAX. INPUT LEVEL	+7 dBm
DAMAGE LEVEL	5 Watts (+37 dBm)
ACQUISITION TIME	~ 250 msec Independent of frequency
AUTO AMPLITUDE DISCRIMINATION	(Automatic amplitude discrimination of two frequencies) 10 dB
FM MODULATION	20 MHz P-P up to 10 MHz rate
VSWR	< 2.5.1 typical
FREQUENCY LIMIT	Keyboard control of desired limits (standard). Counter will measure largest signal within programmed limits. Signal outside operating band must be separated by at least 100 MHz from either limit. For signals more than 10 dB above desired signal, separation is typically 200 MHz

TIME BASE	
FREQUENCY	10 MHz TCXO
AGING RATE	$< \lvert 3 \times 10^{-7} \rvert$ per month
SHORT TERM	$< \lvert 1 \times 10^{-9} \rvert$ rms for one second averaging time.
TEMPERATURE	$< \lvert 2 \times 10^{-6} \rvert$ 0° to + 50°C
LINE VARIATION	$< \lvert 1 \times 10^{-7} \rvert \pm 10\%$ change.
WARM UP TIME	NONE
OUTPUT FREQUENCY	10 MHz, square-wave, 1 V p-p minimum into 50 ohms.
EXT TIME BASE	Requires 10 MHz, 1 V p-p minimim into 300 ohms.

SPECIFICATIONS, continued

BAND 4
Used with 578/06 Counter and 590 Frequency Extension Kit

OPTIONS	91	92	93	94
SELECT BAND	41	42	43	44
Waveguide Band	K a	U	E	W
Range	26.5-40 GHz	40-60 GHz	60-90 GHz	90-110 GHz
Sensitivity (typ)	-25dBm(-20dBm min)	-25 dBm	-25 dBm	-25 dBm
Waveguide Size	Wr-28	WR-19	WR-12	WR-10
Waveguide Flange	UG-599/U	UG-383/U	UG-387/U	UG-387/U
Max. Input (typ)	+5 dBm	+5 dBm	+5 dBm	+5 dBm
Damage Level	+10 dBm	+10 dBm	+ 10 dBm	+10 dBm
Aquisition Time(typ)	< 2.5 sec	< 2.5 sec	< 2.5 sec	< 2.5 sec

EXAMPLE: If desired measurement is 60 – 90 GHz the required equipment is :
Model 578 with Option 06 – Extended Frequency and
Model 590 - Extended Frequency Cable Kit with
Option 93 - Remote Sensor

SOURCE LOCK	
FREQUENCY RANGE	10 MHz - Max. capability of counter.
RESOLUTION	10 kHz for phase lock freq. > 50 MHz 2.5 kHz for < 50 MHz
ACCURACY	Equal to counter's Time Base
LONG TERM STABILITY	Equal to counter's Time Base
MIN. PHASE LOCK SIGNAL LEVEL	Equal to counter sensitivity
POLARITY	Automatically selected
BANDWIDTH	User select, 10 kHz, 2 kHz or 500 Hz, or automatically selects widest bandwidth capable of locking.
LOCK TIME (TYP)	
COARSE TUNE	50 m sec + 1 counter aquisition time for source bandwidth greater than 100 Hz, Limited by source tuning speed below 100 Hz.
PHASE LOCK	200 m sec
RECALLING STORED DATA	1 counter aquisition + 100 m sec limited by source tuning speed.
OUTPUT DRIVE (MAX)	
COARSE TUNE OUTPUT	+ 10 V into 5 K ohm min.
PHASE LOCK OUTPUT	± 10 V into 5 K ohm min for source gain constant < 64 MHz/V. ± 75 MA into 10 ohm max for source gain constant < 3.2 MHz/MA. ± 6 V into 5 K ohm min for source gain constant > 64 MHz/V. ± 4.5 MA into 10 ohm max for source gain constant > 3.2 MHz/MA.
CAPTURE RANGE	
COARSE TUNE	Entire range of selected counter band limited by maximum output drive.
PHASE LOCK	Source gain constant X maximum output drive.

SPECIFICATIONS, continued

OUTPUT CONNECTOR	
COARSE TUNE	Rear panel BNC, female
PHASE LOCK	Rear panel BNC, female

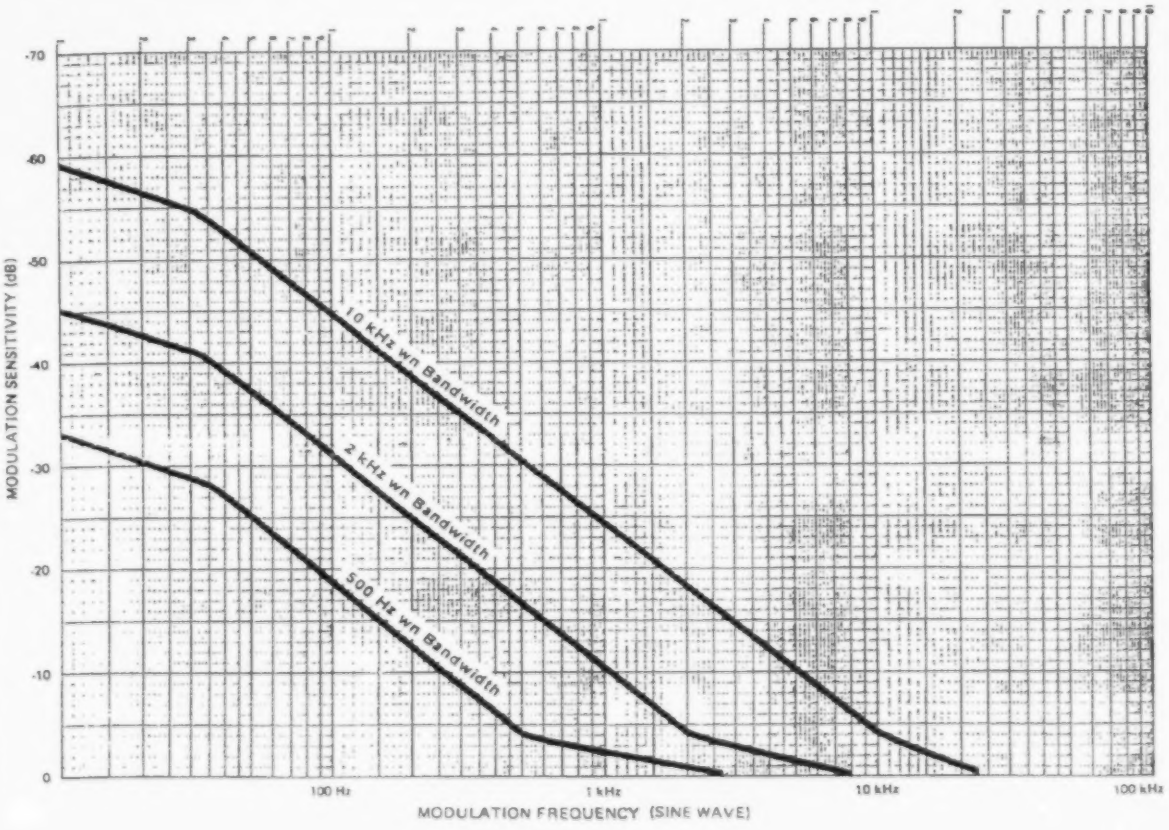
PHASE LOCKED SPECTRUM

NOISE FLOOR vs INPUT FREQUENCY :

The noise floor extends from the carrier to approximately the loop bandwidth. Beyond this the noise floor decreases 12 dB / bandwidth octave. The noise floor is the greater of :

1. NOISE FLOOR = -70 dBC / Hz
2. NOISE FLOOR = (20 log F -65) dBC / Hz
   where F = Input frequency in GHz

NOISE REDUCTION vs MODULATION FREQUENCY :

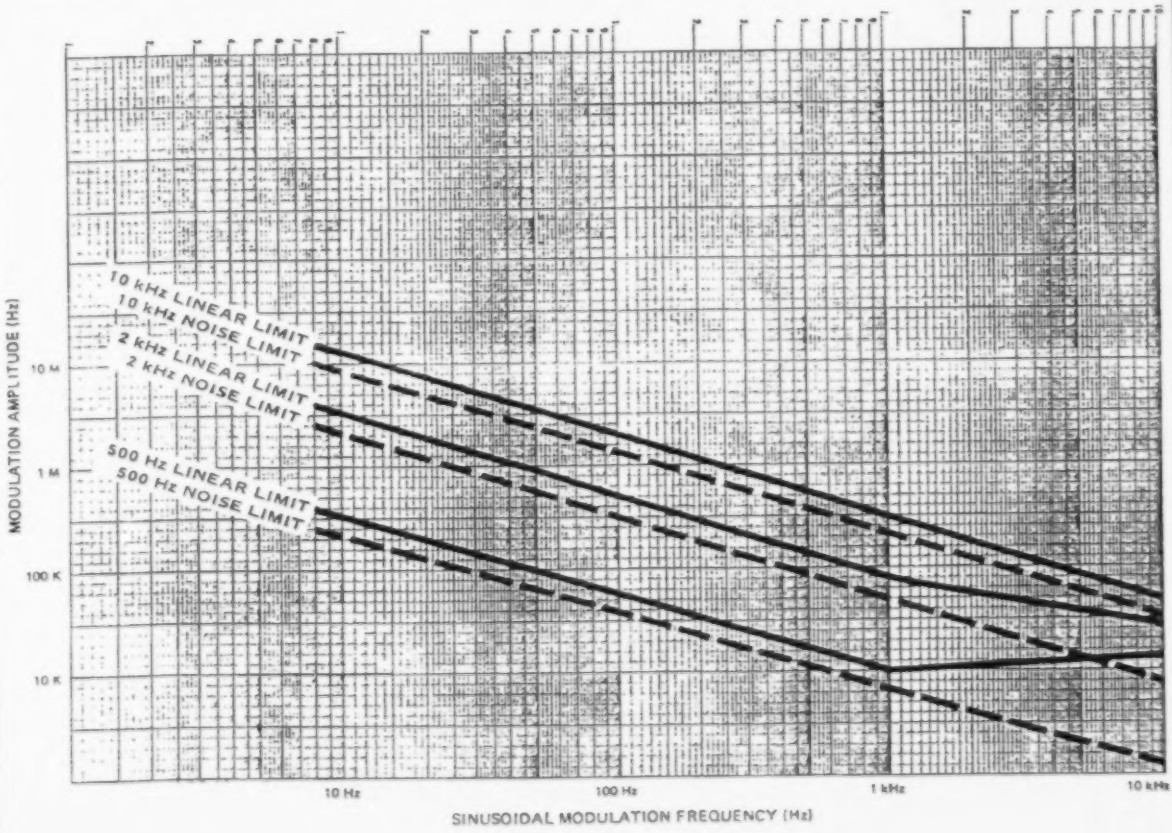


SPECIFICATIONS, continued

SOURCE CHARACTERISTICS (required)	
COARSE TUNE INPUT :	
BANDWIDTH	5 Hz minimum
TUNING SENSITIVITY	10 MHz / V minimum 10 GHz / V maximum
PHASE LOCK (FM) INPUT :	
BANDWIDTH	2 kHz minimum
TUNING SENSITIVITY :	
VOLTAGE DRIVEN INPUT	± 2 MHz / V minimum ± 1000 MHz / V maximum
CURRENT DRIVEN INPUT	± 0.1 MHz / mA minimum ± 50 MHz / mA maximum

MAXIMUM FM

The counter will still frequency stabalize if maximum FM is exceeded, but accuracy and long term stability will not equal the counter's time base.



SPECIFICATIONS, continued

OPTIONS

01 D TO A CONVERTER
DAC will convert any three consecutively displayed digits into an analog voltage output on rear panel.

02 POWER METER
1 to 18/26.5 GHz will measure sine wave amplitude to 0.1 dBm resolution and display simultaneously with frequency.
Power offset to 0.1 dB resolution, selectable from front panel.
Option will not degrade the basic performance of the counter.

NOTE
Power Meter and Source Locking cannot be active at the same time.

TIME BASE OSCILLATOR OPTIONS:

	03	04	05
AGING RATE/24 HOURS (After 72 hour warm-up)	$<\lvert 5 \times 10^{-9} \rvert$	$<\lvert 1 \times 10^{-9} \rvert$	$<\lvert 5 \times 10^{-10} \rvert$
SHORT TERM STABILITY (1 second average)	$< 1 \times 10^{-10}$ rms	$< 1 \times 10^{-10}$ rms	$< 1 \times 10^{-10}$ rms
0° to +50° C TEMPERATURE STABILITY	$<\lvert 6 \times 10^{-8} \rvert$	$<\lvert 3 \times 10^{-8} \rvert$	$<\lvert 3 \times 10^{-8} \rvert$
± 10% LINE VOLTAGE CHANGE	$<\lvert 5 \times 10^{-10} \rvert$	$<\lvert 2 \times 10^{-10} \rvert$	$<\lvert 2 \times 10^{-10} \rvert$

06 EXTENDED FREQUENCY CAPABILITY – 578
Use in conjunction with model 590 Frequency Extension Cable kit and a remote sensor.

09 REAR INPUT

10 CHASSIS SLIDES

Appendix C: Figures

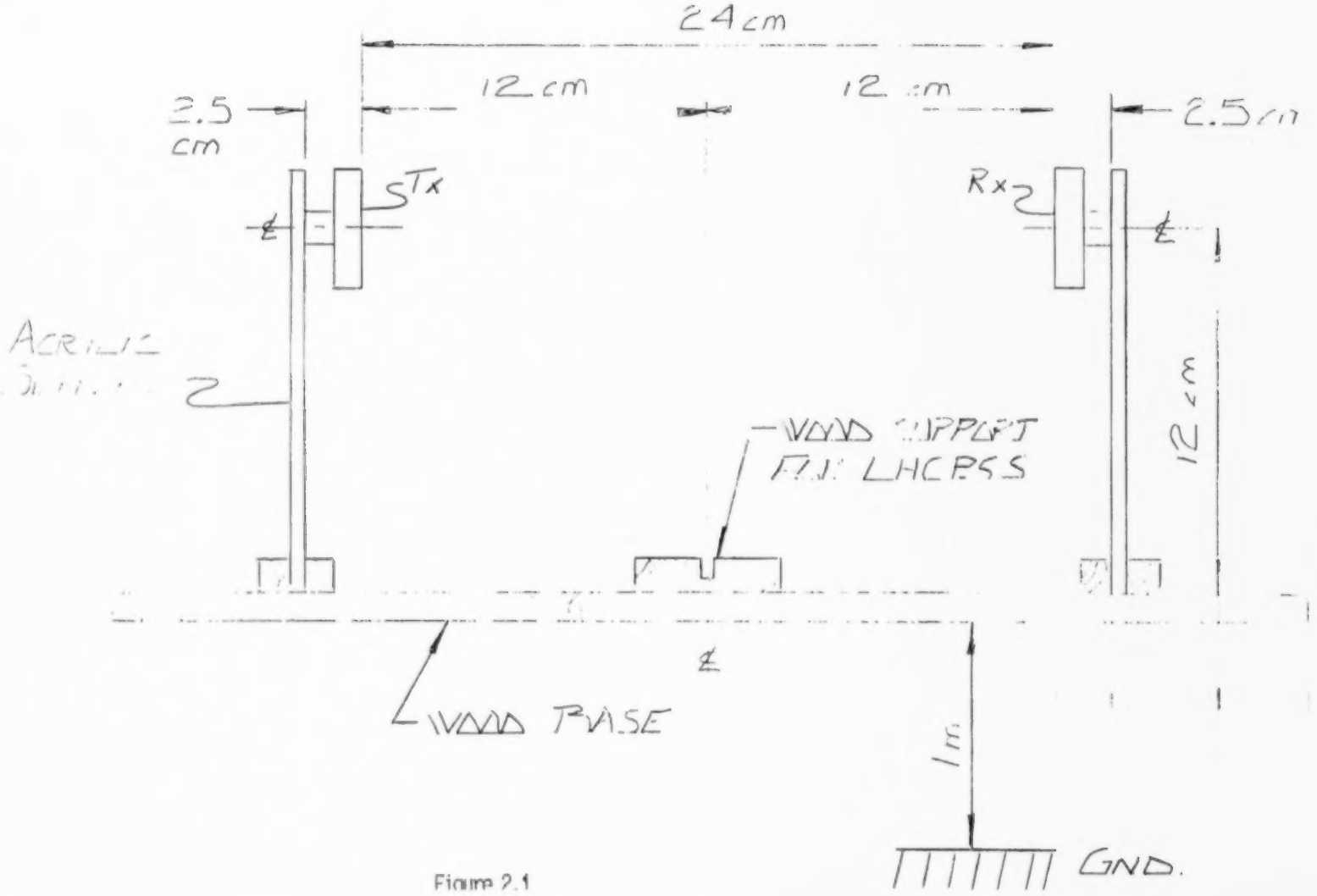


Figure 2.1

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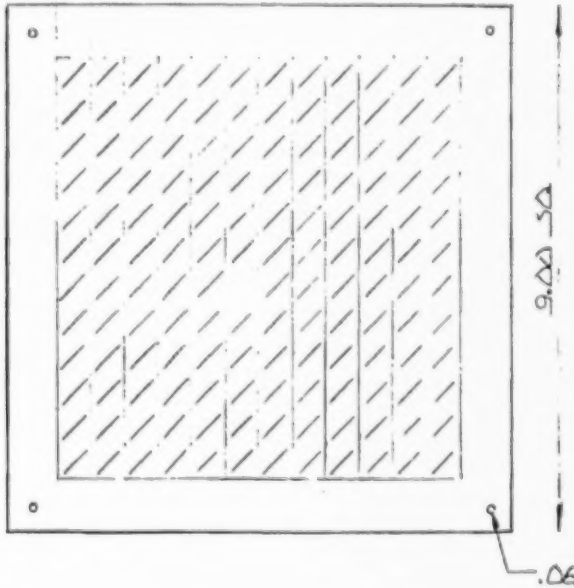
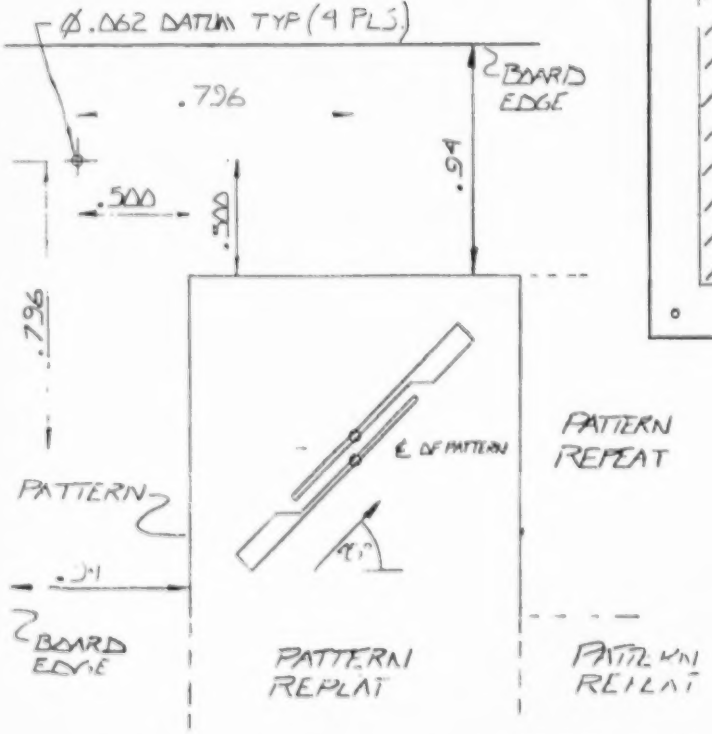
REVISIONS				
LTR	DESCRIPTION	D	M	Y	APP'D

PATTERN LAYOUT



DATUM PLACEMENT



NOTES

- LAYOUT CONSISTS OF 144 PATTERNS IN A 12 x 12 ARRANGEMENT ON A 9"x9" BOARD. THE PATTERN ORIENTATION IS 45° DIAG.
- PATTERN SIZE - .592" SQ
- REFER TO SHEET ONE FOR PATTERN DETAIL

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN DECIMAL INCHES TOLERANCES ON: DECIMALS .XXX ±.005 .XX ±.03 ANGLES ±1/2°	CONTRACT V7714-8-5651/01-SV	TIL-TEK Limited KEMPTVILLE ONTARIO CANADA
	DRAWN JT DATE MAY 89	PATTERN LAYOUT
	CHECKED DATE	
MATERIAL .125 RT DUROID "3971A - 1/2 OZ CU"	ELECTRICAL APPROVED DATE	SIZE B PSS-TEST-01 REV
FINISH: TIN PLATE	MECHANICAL APPROVED DATE	SCALE USED ON REV. (S) SHEET SHEET 2 OF 2

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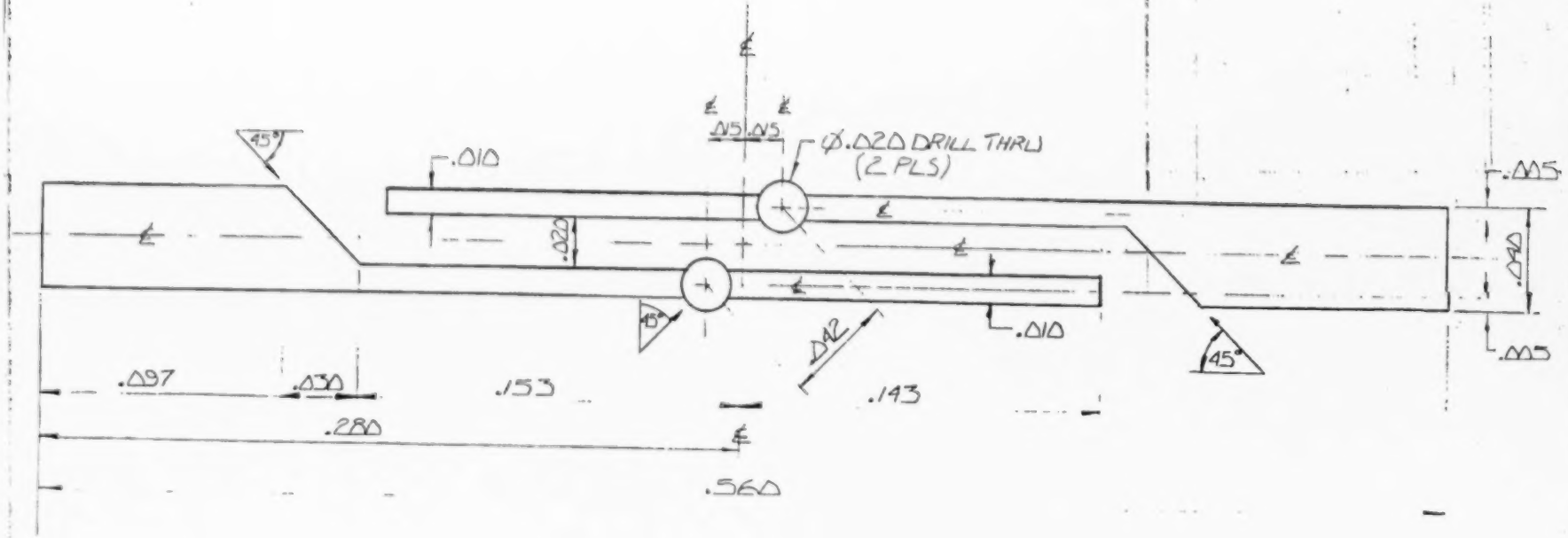
REVISIONS					
LTR	DESCRIPTION	D	M	Y	APP



NOTES:

- ALL DIMENSIONS TYPICAL (PATTERN SYMMETRICAL)

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN DECIMAL INCHES TOLERANCES ON: DECIMALS .XXX ± .005 ANGLES ± 1/2° .XX ±	CONTRACT V774-B - 5651/01-SV	TIL-TEK Limited KEMPTVILLE ONTARIO CANADA
	DRAWN JT DATE MAY 89	DIPOLE DETAIL
MATERIAL #5870 RT DURAID ½ OZ CI	CHECKED DATE	SIZE B — PSS-TEST-01 — REV
FINISH TIN PLATE	ELECTRICAL APPROVED DATE	SCALE 2.5:1 — USED ON VOL 01 SLIFF — SHEET — OF
	MECHANICAL APPROVED DATE	

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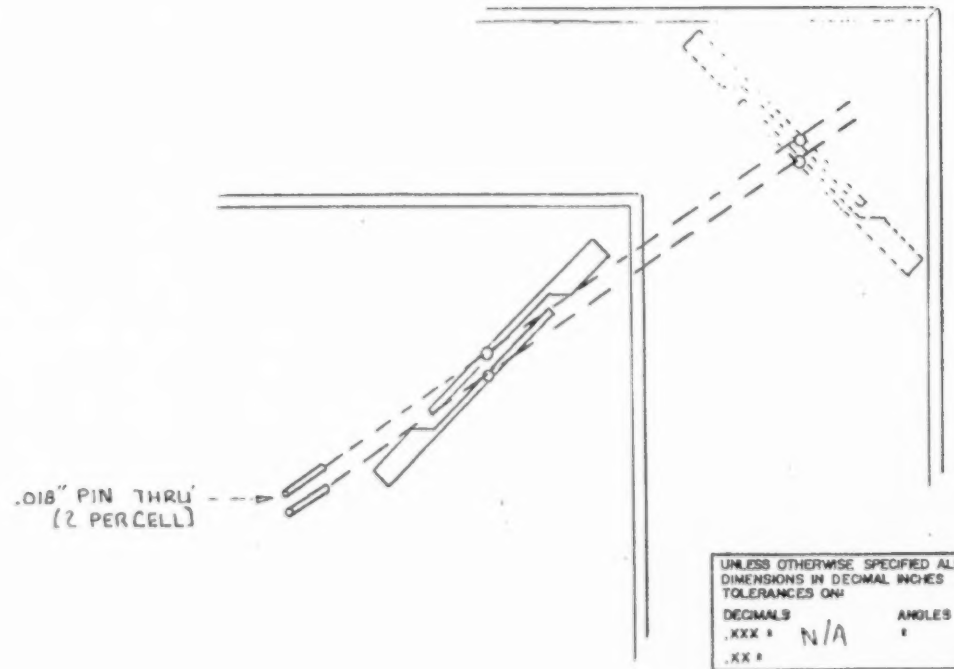
REVISIONS				
LTR	DESCRIPTION	D	M	Y	APP



UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN DECIMAL INCHES TOLERANCES ON: DECIMALS .XXX ± N/A, .XX ±; ANGLES °	CONTRACT W7701-[illegible] S631/01 [illegible]V	TIL-TEK Limited KEMPTVILLE ONTARIO CANADA
	DRAWN DT DATE OCT 86	ASSEMBLY DWG
MATERIAL	CHECKED DATE	
FINISH	ELECTRICAL APPROVED DATE	SIZE B — PSS-TEST SAMPLE #1 — REV
	MECHANICAL APPROVED DATE	SCALE — USED ON — SHEET OF

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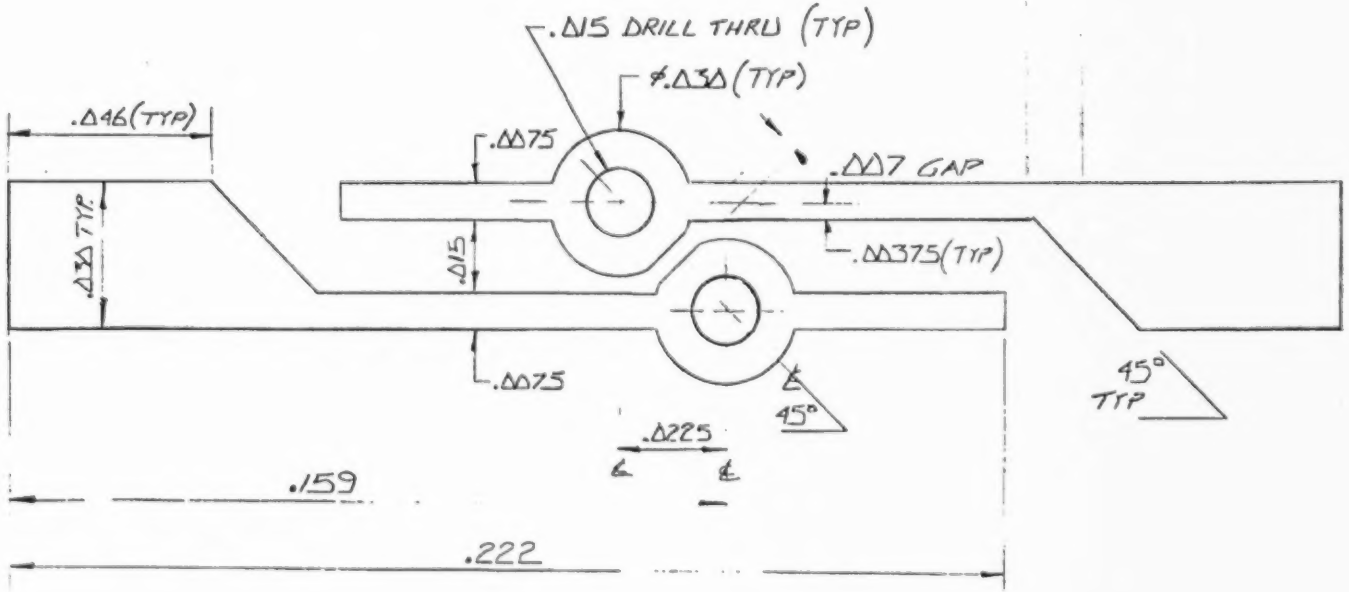
REVISIONS				
LTR	DESCRIPTION	D	M	Y	APP'D



NOTES:

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN DECIMAL INCHES TOLERANCES ON: DECIMALS .XXX ± .XX ± ANGLES ±	CONTRACT DREA SATCOM	TIL-TEK Limited KEMPTVILLE ONTARIO CANADA
MATERIAL RT DUROID 5870	DRAWN JT DATE SEPT 89	15.5 GHz POLARIZATION SELECTIVE SURFACE
FINISH ELECTRA-TIN PLATE	CHECKED DATE	SIZE B REV
	ELECTRICAL APPROVED DATE	SCALE 40:1 USED ON SHEET 1 OF 2
	MECHANICAL APPROVED DATE	

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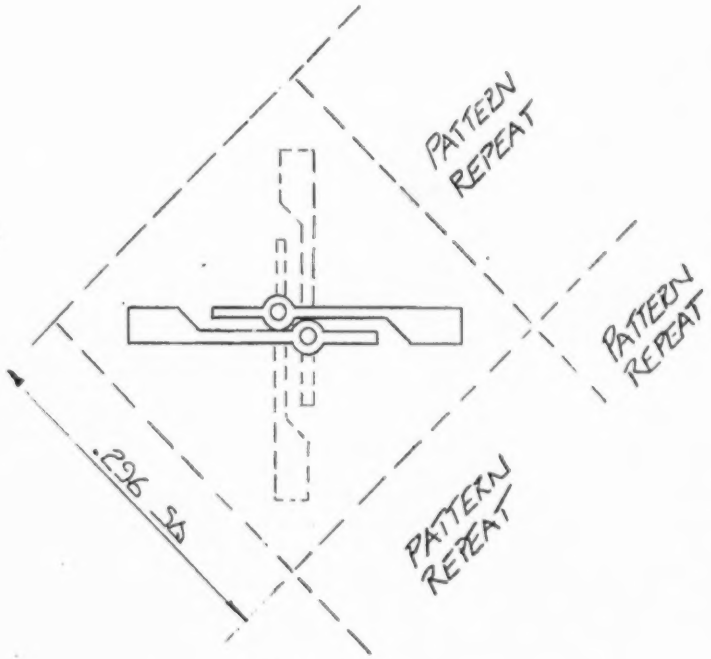
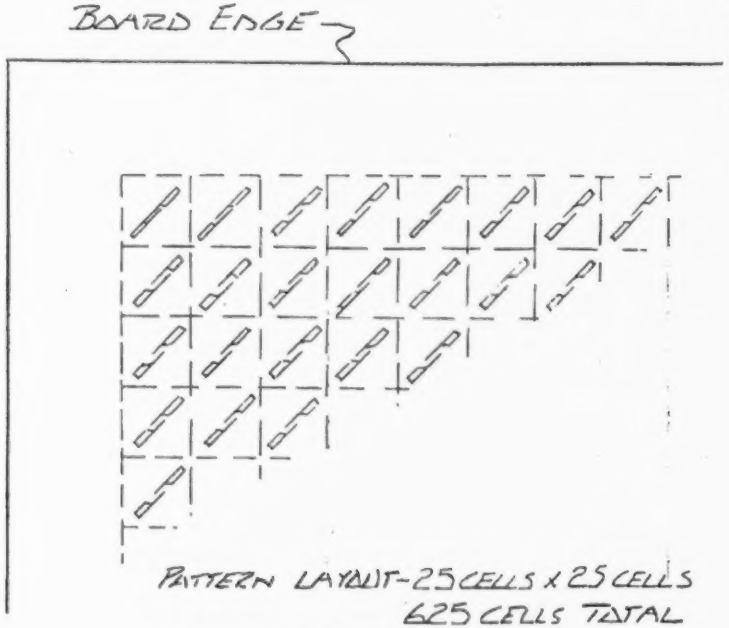
REVISIONS				
LTR	DESCRIPTION	D	M	Y	APP'D



CELL SIZE
.296 x .296



PATTERN LAYOUT-25 CELLS x 25 CELLS
625 CELLS TOTAL
PATTERN ROTATED 45°

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN DECIMAL INCHES TOLERANCES ON: DECIMALS .XXX ± .XX ± ANGLES ±	CONTRACT DREA SATCOM	TIL-TEK Limited KEMPTVILLE ONTARIO CANADA
MATERIAL RT DUROID 5870	DRAWN AT SEPT 89 DATE	15 GHz PSS CELL LAYOUT
FINISH EXTRA TIN PLATE	CHECKED DATE	SIZE D REV
	ELECTRICAL APPROVED DATE	SCALE N.T.S USED ON SHEET 2 OF 2
	MECHANICAL APPROVED DATE	

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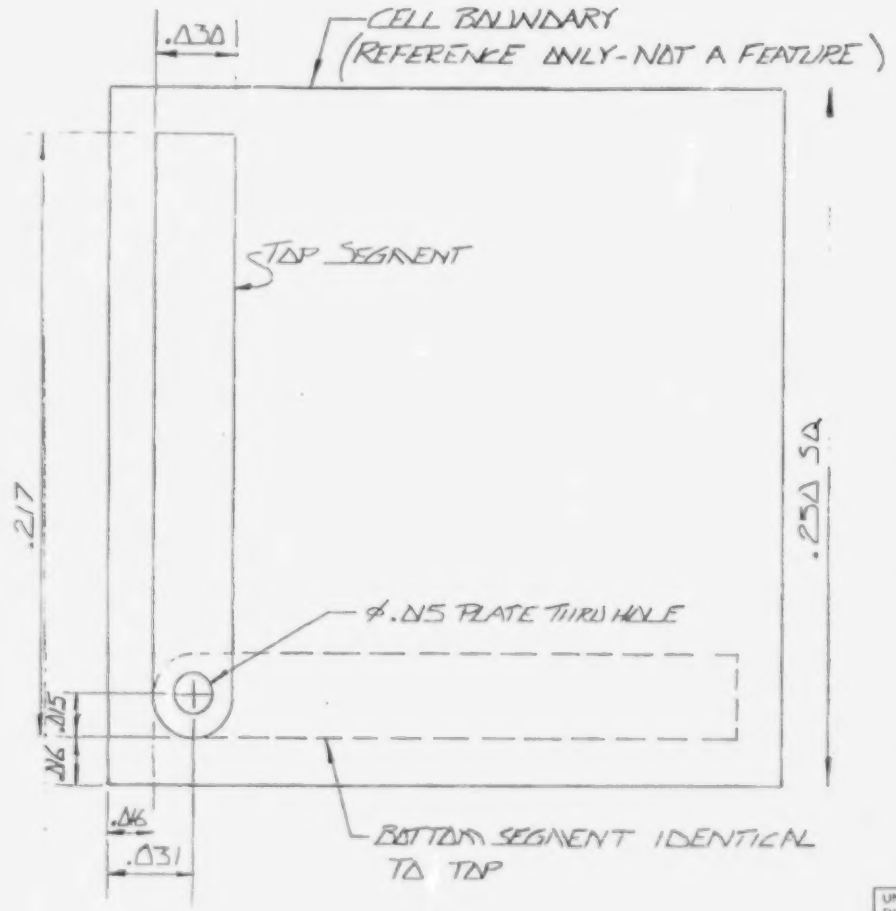
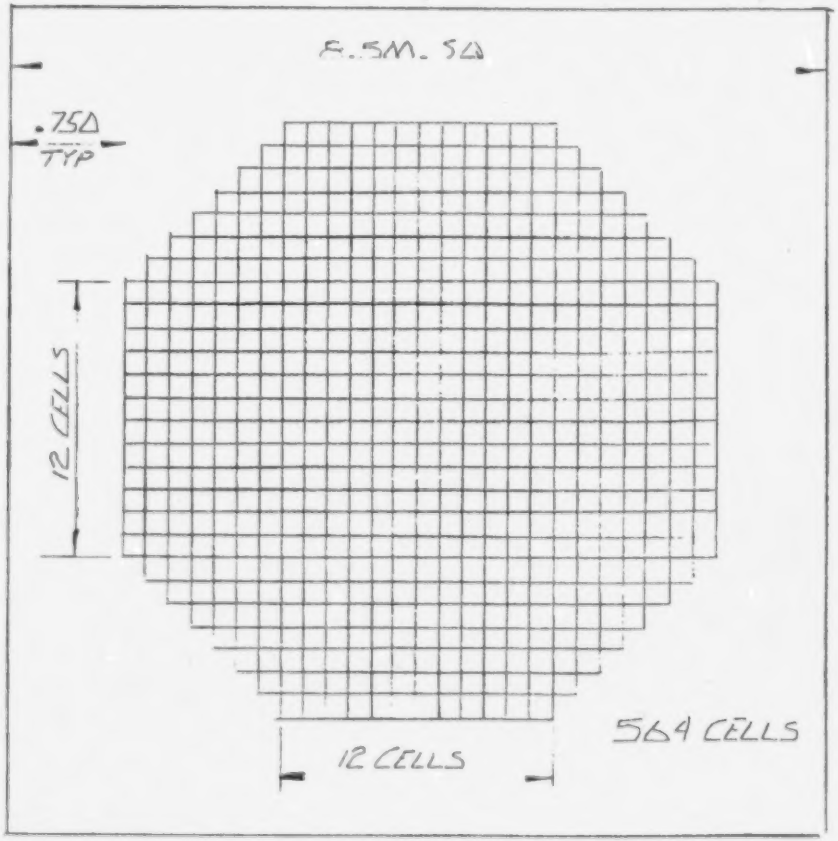
REVISIONS				
LTR	DESCRIPTION	D	M	Y	APP'D





UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN DECIMAL INCHES TOLERANCES ON: DECIMALS XXX ± .002, XX ±, ANGLES °	CONTRACT CHF SATCOM	TIL-TEK Limited KEMPTVILLE ONTARIO CANADA
MATERIAL RT DUROID 5870	DRAWN HT DATE NOV 89	LIKE CPSS CELL
FINISH FLECTRA TIN PLATE	CHECKED DATE	SIZE B, REV
	ELECTRICAL APPROVED DATE	SCALE 2/1 USED ON SHEET 1 OF 1
	MECHANICAL APPROVED DATE	

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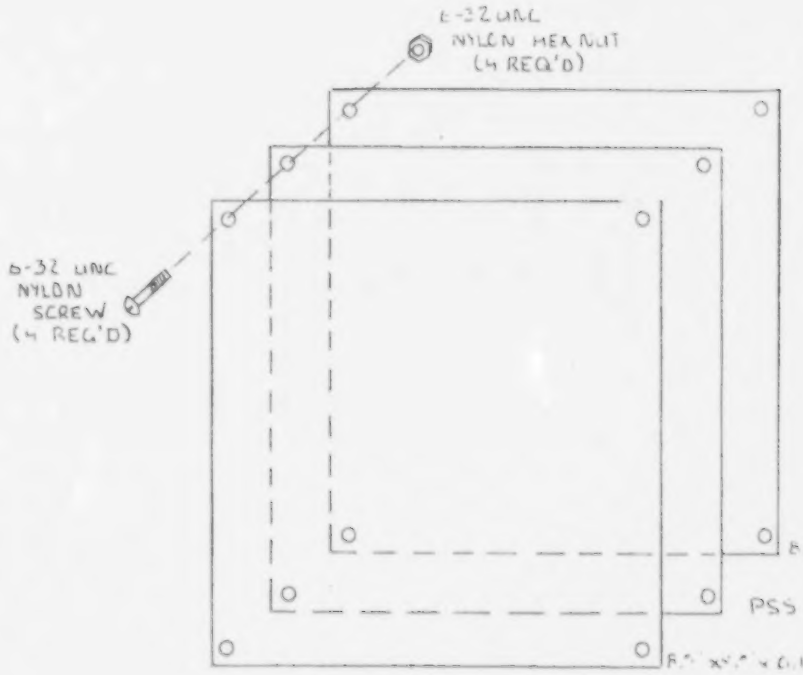
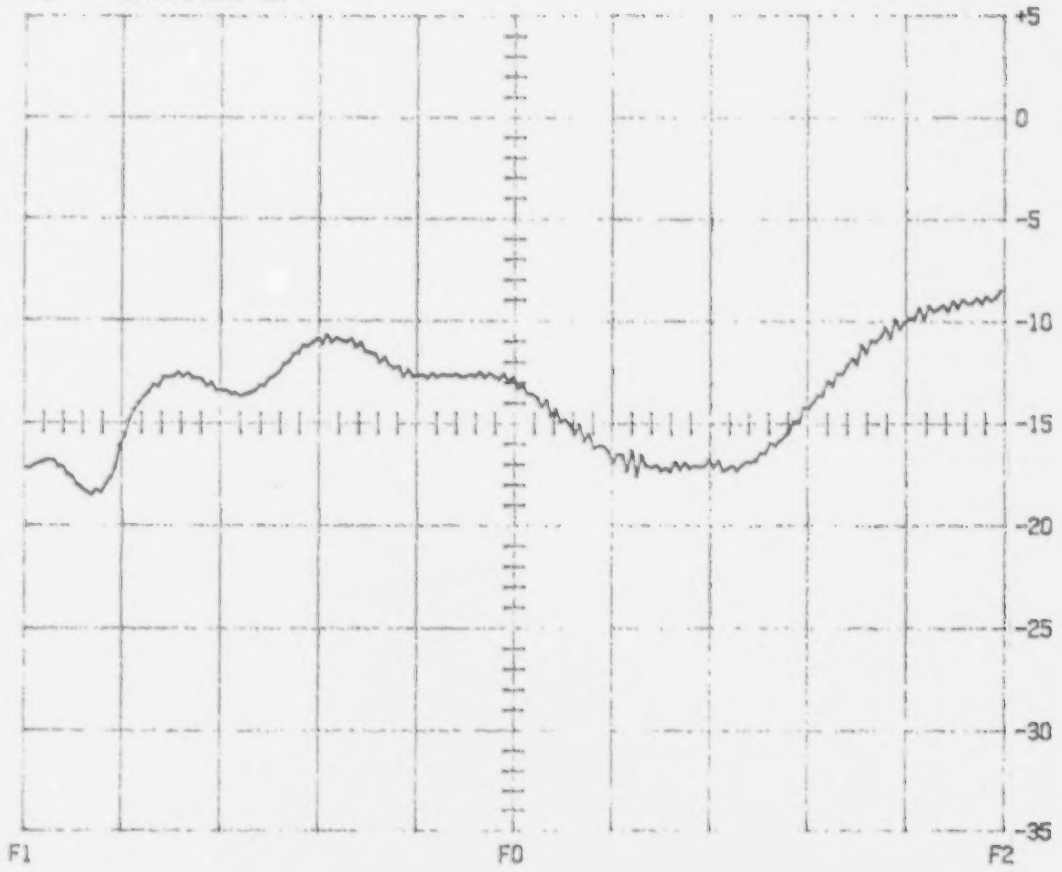
LTR	DESCRIPTION	D	M	Y	APP'D



UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN DECIMAL INCHES TOLERANCES ON: DECIMALS .XXX ± N/A, .XX ±, ANGLES ±	CONTRACT W 7711-8-5631-SV	TIL-TEK Limited KEMPTVILLE ONTARIO CANADA
MATERIAL	DRAWN D.T. DATE OCT. 96	ASSEMBLY DWG
FINISH	CHECKED DATE	SIZE B — PSS-TEST SAMPLE #3 — REV
	ELECTRICAL APPROVED DATE	SCALE — USED ON — SHEET OF
	MECHANICAL APPROVED DATE	

MODEL #: ASO-1601A

A: RETURN LOSS 5 DB/DIV. N.L. =-58.18 DB.
B: CHANNEL OFF



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: 088
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - - - -
TRANS. LOSS: ———————

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 0 DBM.

Figure # 4.2.1

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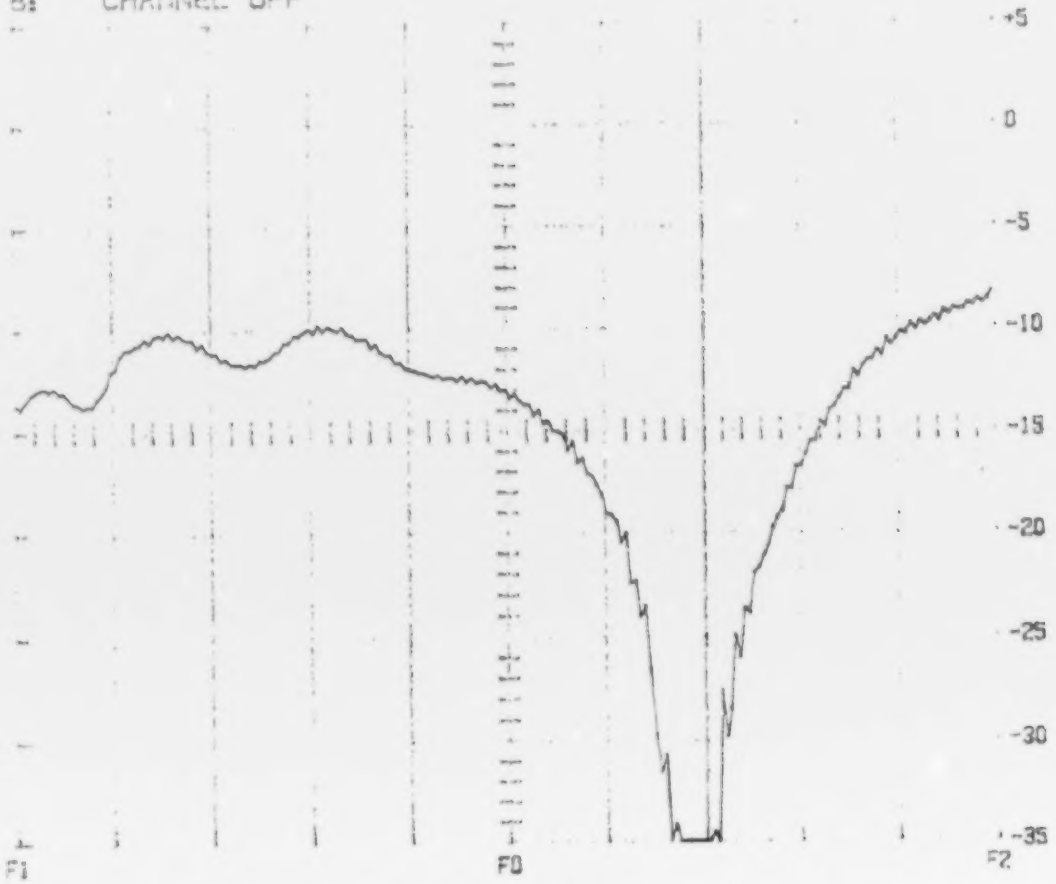
MODEL #: ASO-1601A

A: RETURN LOSS 5 DB/DIV. N.L. =-51.98 DB.
B: CHANNEL OFF



DATE: 06-06-89
SERIAL #: 089
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - - -

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

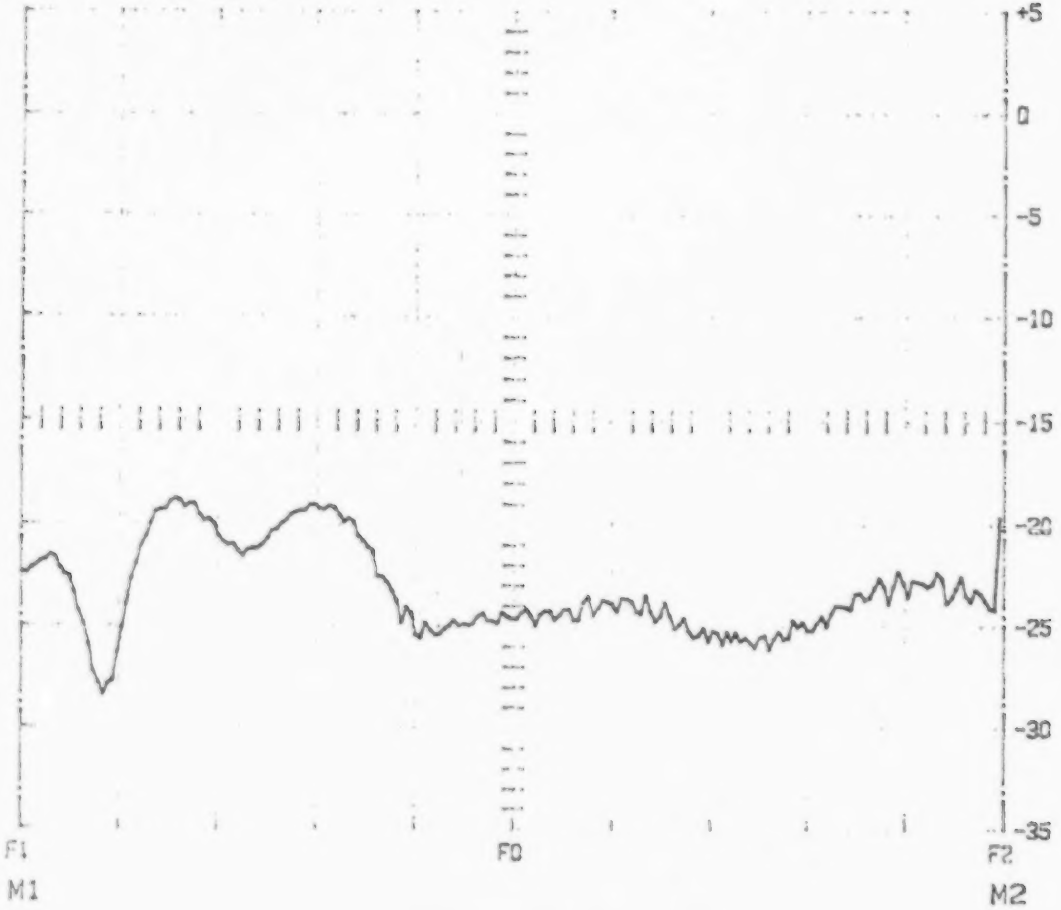
POWER LEVEL : 0 DBM.

Figure # 4.2.2

MODEL #: ASO-1601AA

A: RETURN LOSS 5 DB/DIV. R.L.=-56.35 DB.

B: CHANNEL OFF



DATE: 06-06-89
SERIAL #: 020
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: - - - -

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 0 DBM.

Figure # 4.2.3

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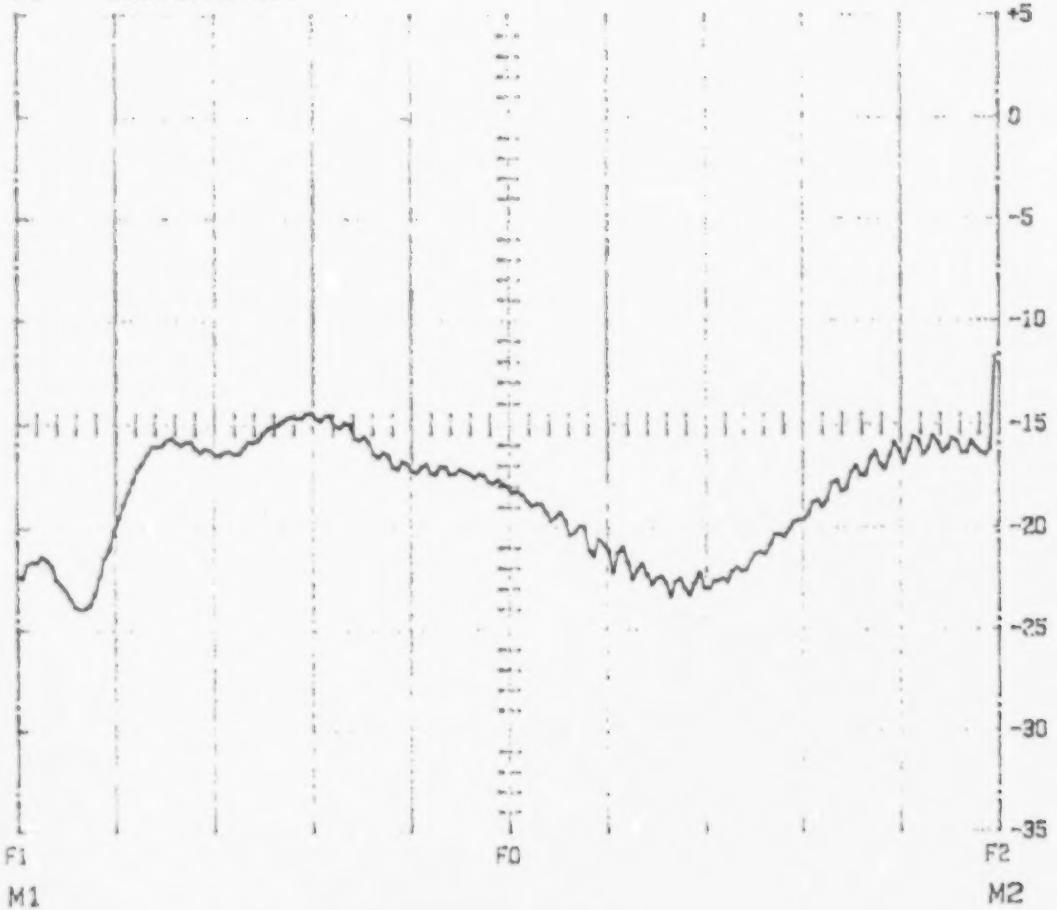
MODEL #: ASO-1601AA

A: RETURN LOSS 5 DB/DIV. M.L.=-57.13 DB.
B: CHANNEL OFF



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: 021
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————————
TRANS. LOSS: - - - - -

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 0 DBM.

Figure # 4.2.4

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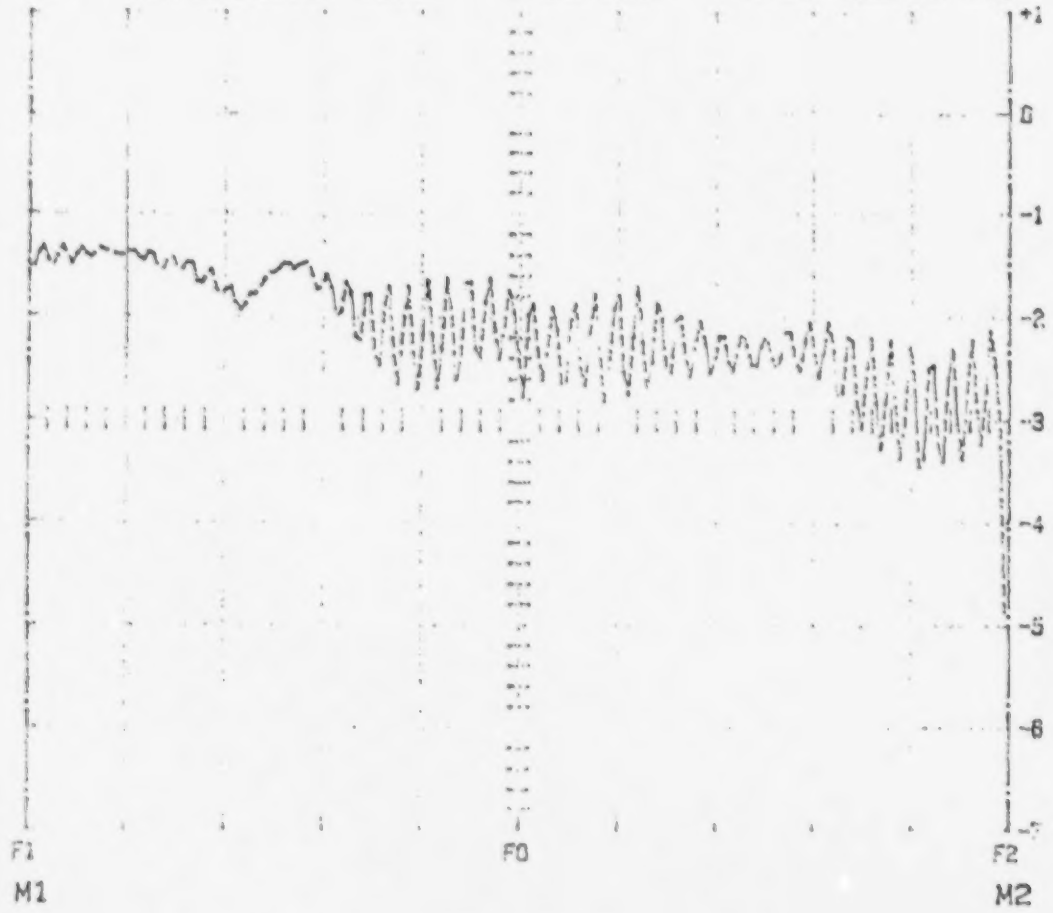
MODEL #: CABLE LOSS

A: CHANNEL OFF
B: TRANSMISSION LOSS 1 DB/DIV. M.L.=-58.62 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ---
TRANS. LOSS: ---

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.5

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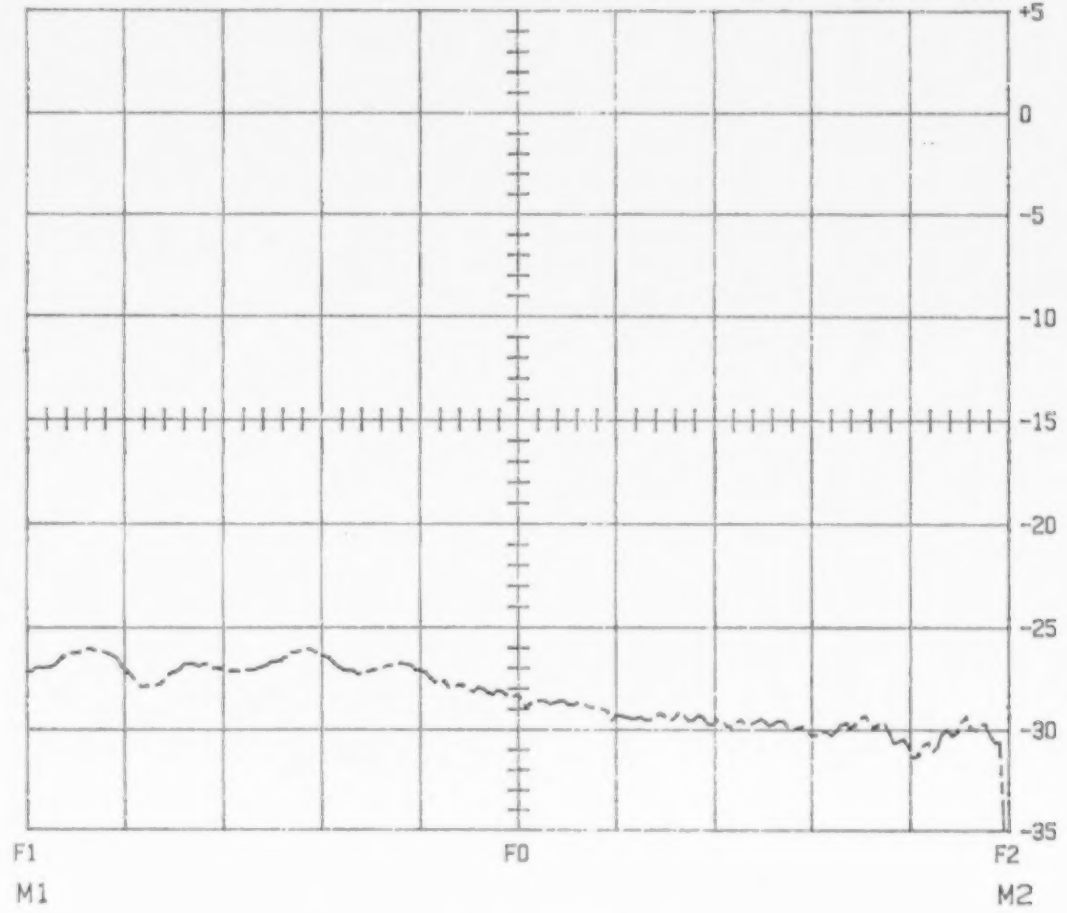
MODEL #: RHCP-RHCP PATH LOSS

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N. L. =-58. 72 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D. A. T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: — - - —

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.6

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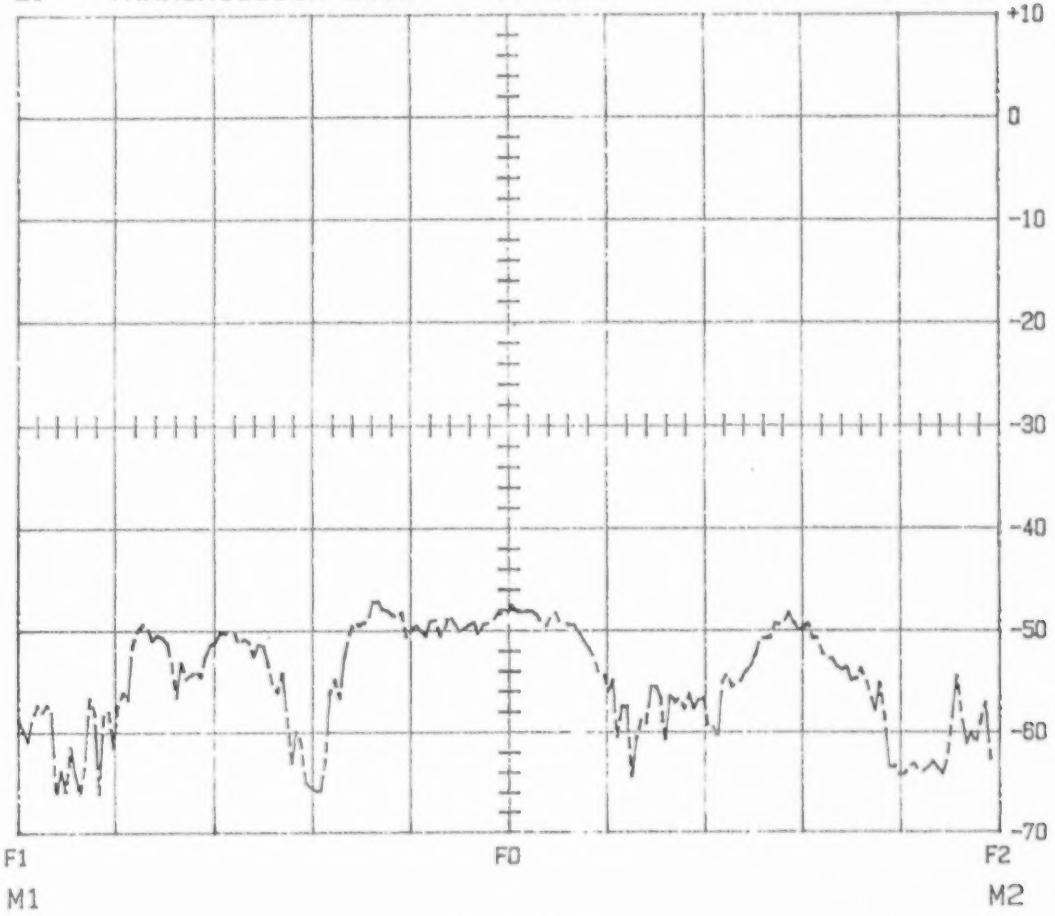
MODEL #: RHCP-LHCP PATH LOSS

A: CHANNEL OFF
B: TRANSMISSION LOSS 10 DB/DIV. N.L. =-55.63 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - - - -

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.7

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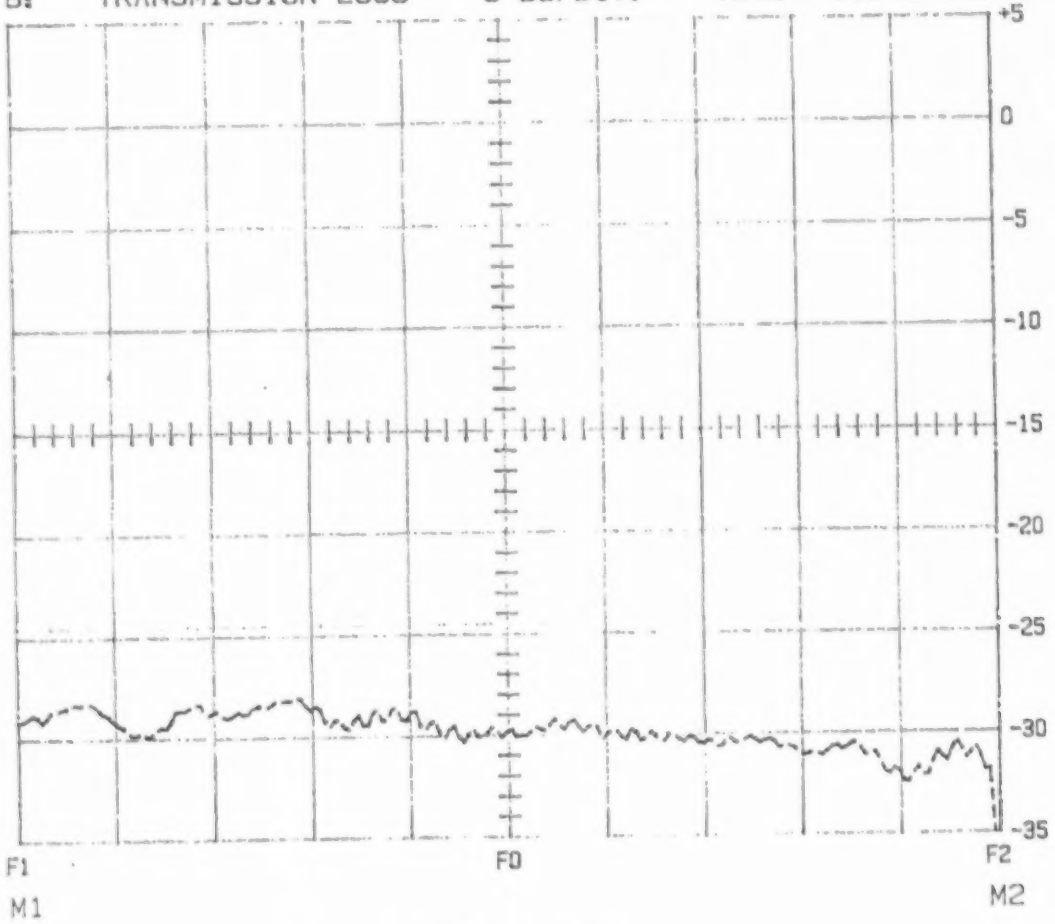
MODEL #: LHCP-LHCP PATH LOSS

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.60 DB.



DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - - -

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure #. 4.2.8

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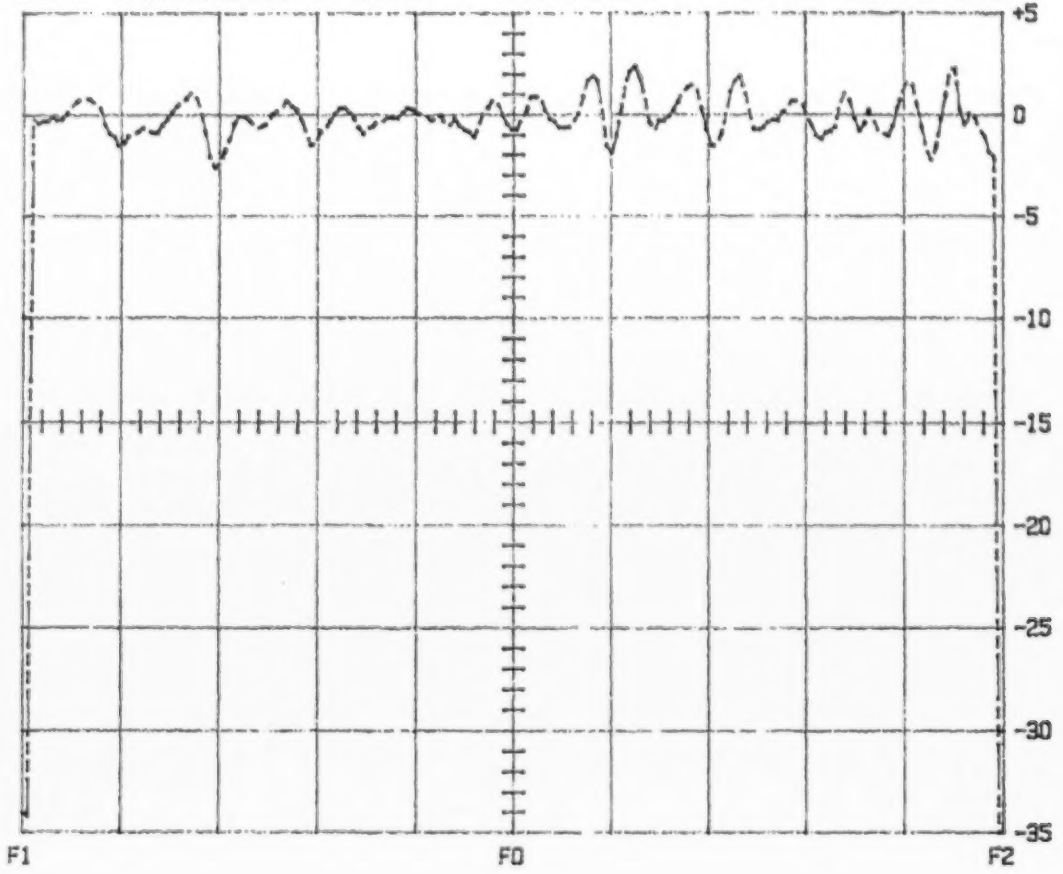
MODEL #: TRANSMISSION THRU' 1/4" DIELECTRIC

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.30 DB.



(DB.)

(FREQUENCY)

DATE: 06-27-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ------
TRANS. LOSS: ------

F0 : 9375 MHZ.
F1 : 3750 MHZ.
F2 : 15000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure 4.2.9

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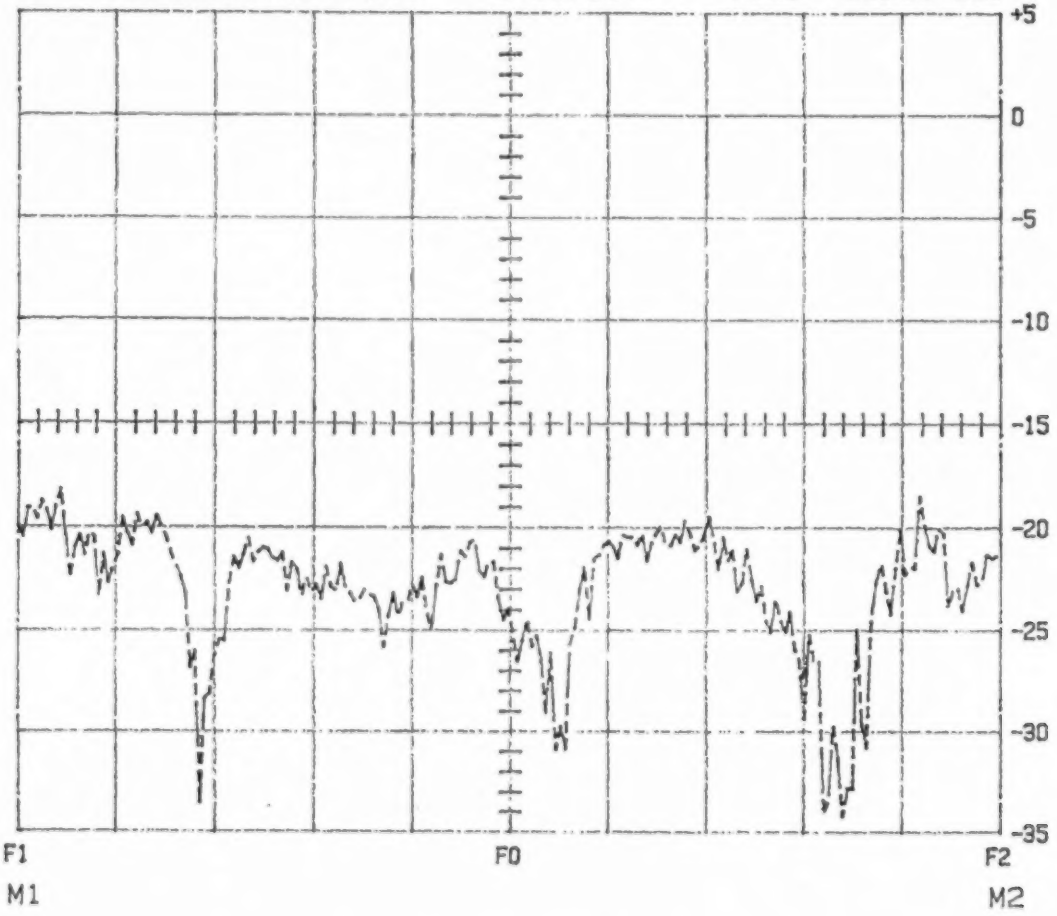
MODEL #: LHCP ATTENUATION DUE TO PLATE 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.60 DB.



DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - - -

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.10

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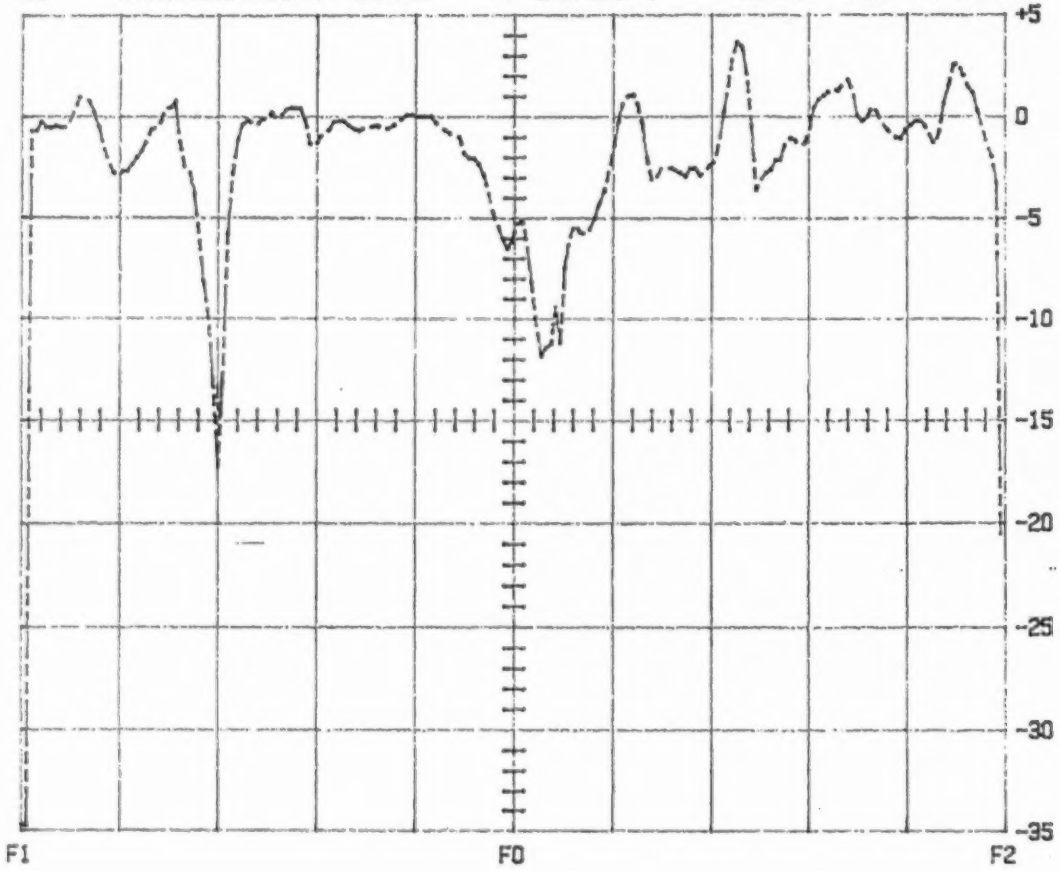
MODEL #: LHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.44 DB.



(DB.)

(FREQUENCY)

DATE: 06-27-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - -

F0 : 9375 MHZ.
F1 : 3750 MHZ.
F2 : 15000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure 4.2.11

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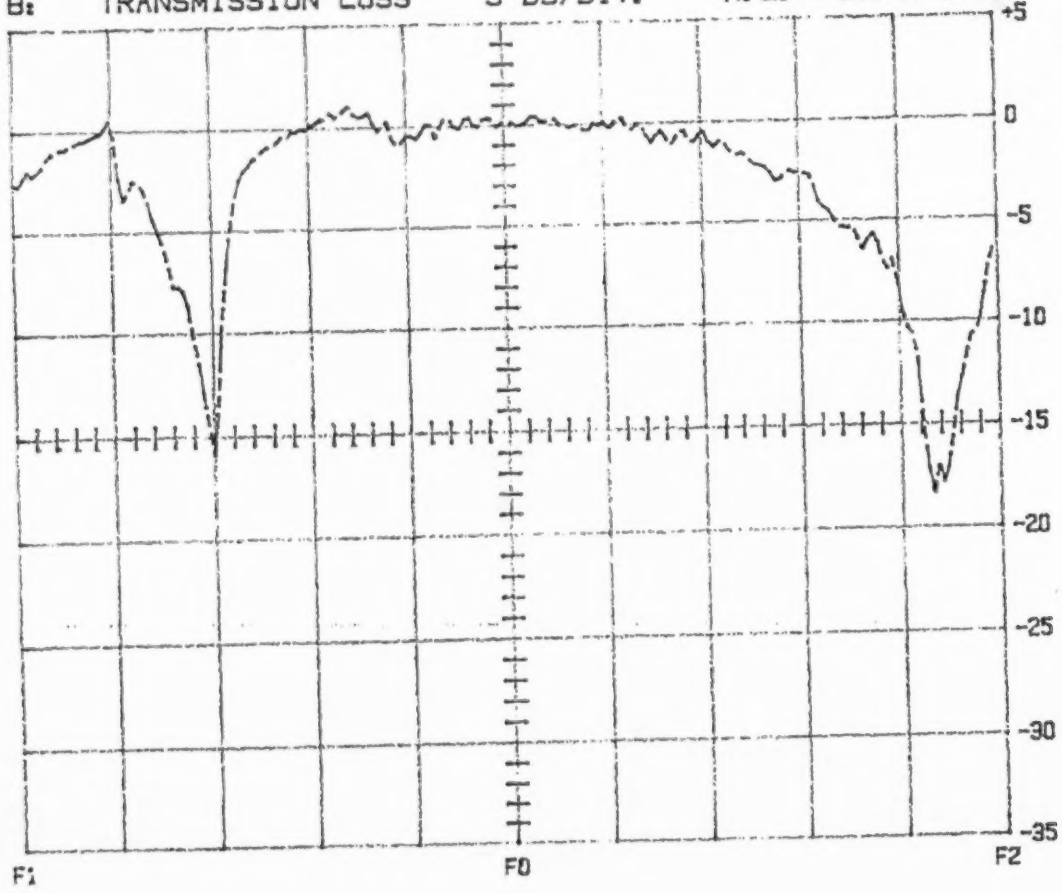
MODEL #: LHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.48 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - - -

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure 4.2.12

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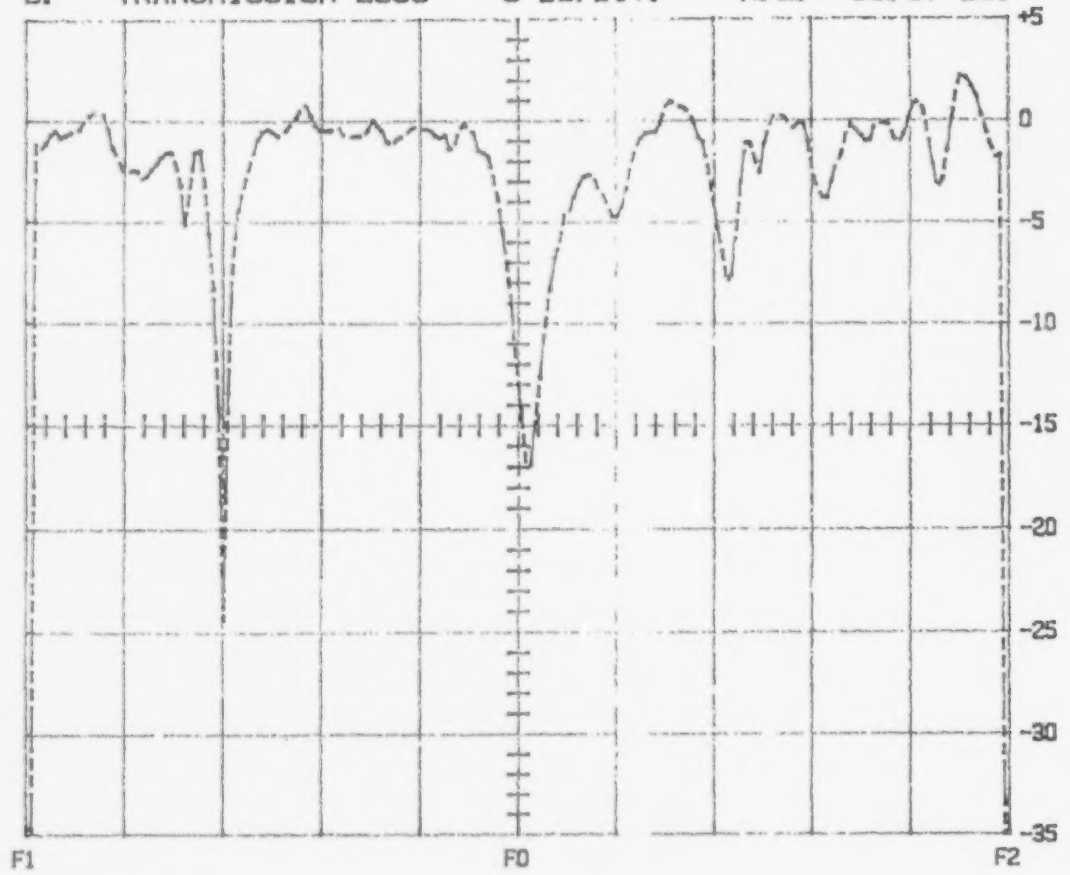
MODEL #: LHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-56.67 DB.



(DB.)

(FREQUENCY)

DATE: 06-27-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - - - -
TRANS. LOSS: ——————

F0 : 9375 MHZ.
F1 : 3750 MHZ.
F2 : 15000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure 4.2.13

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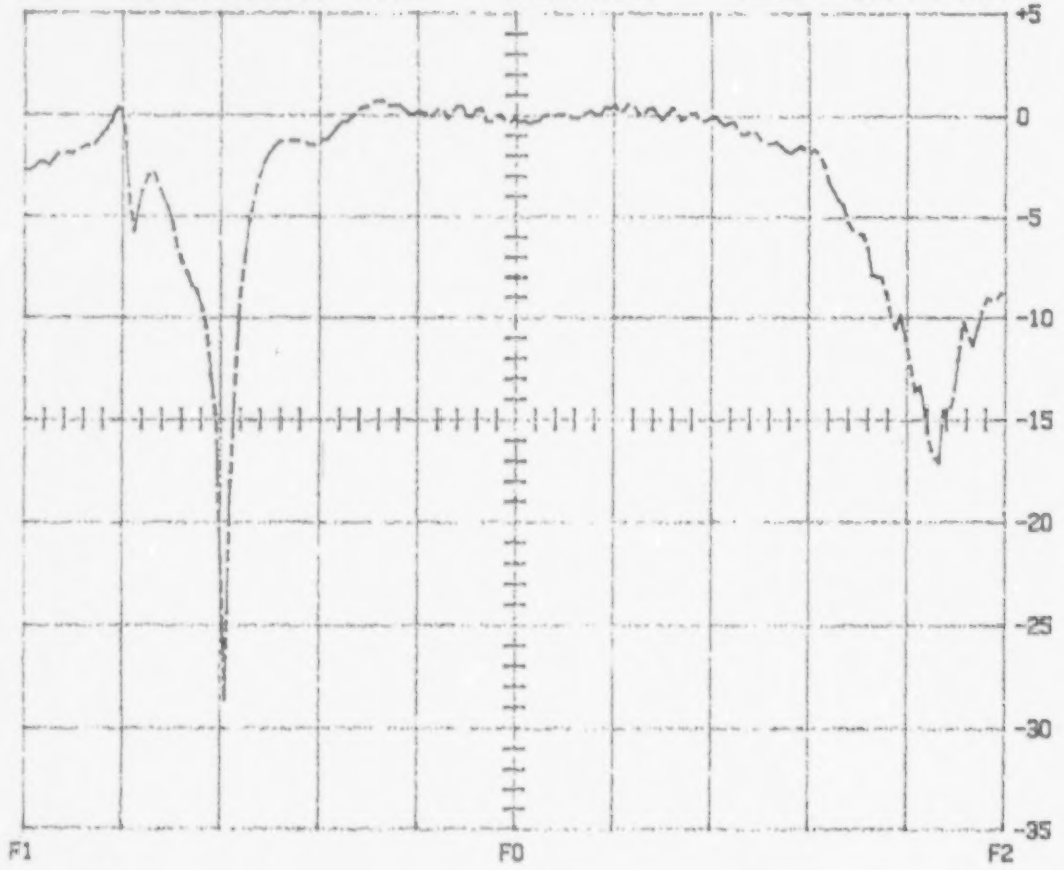
MODEL #: LHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.71 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: ——————

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.14

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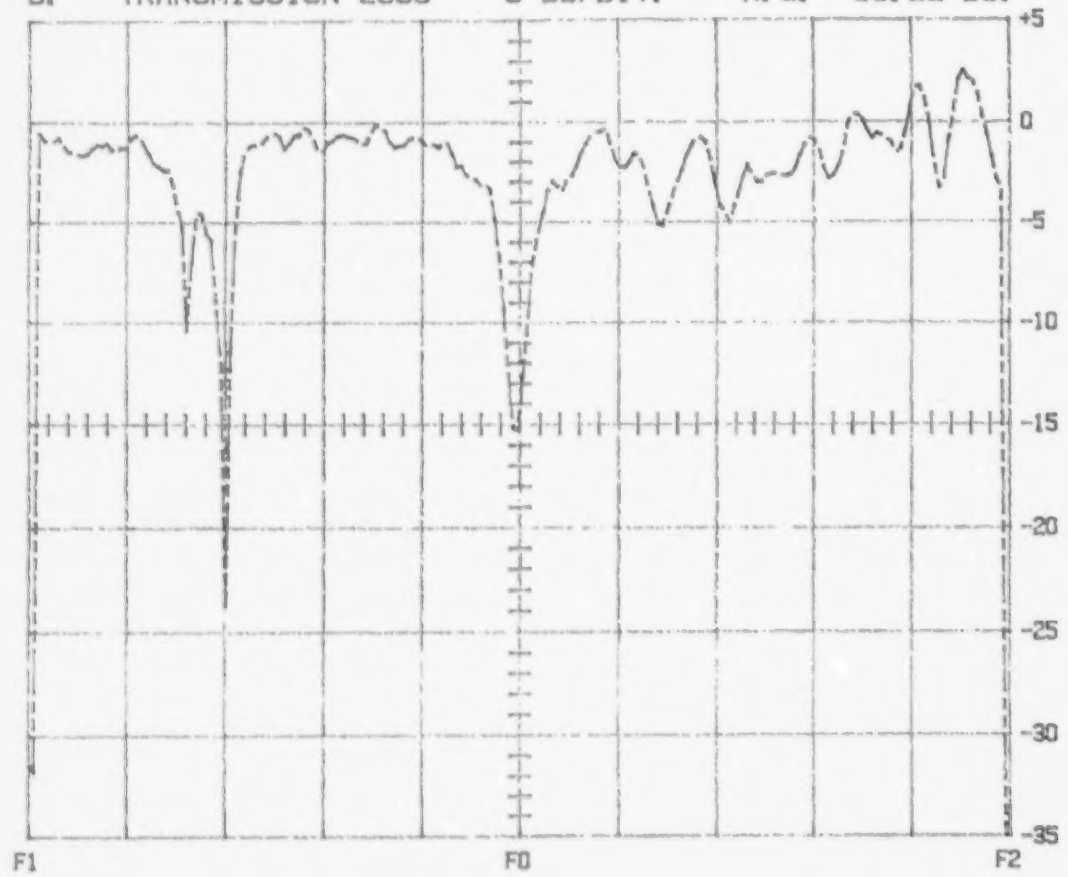
MODEL #: LHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.22 DB.



(DB.)

(FREQUENCY)

DATE: 06-27-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - - - -
TRANS. LOSS: ——————

F0 : 9375 MHZ.
F1 : 3750 MHZ.
F2 : 15000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure 4.2.15

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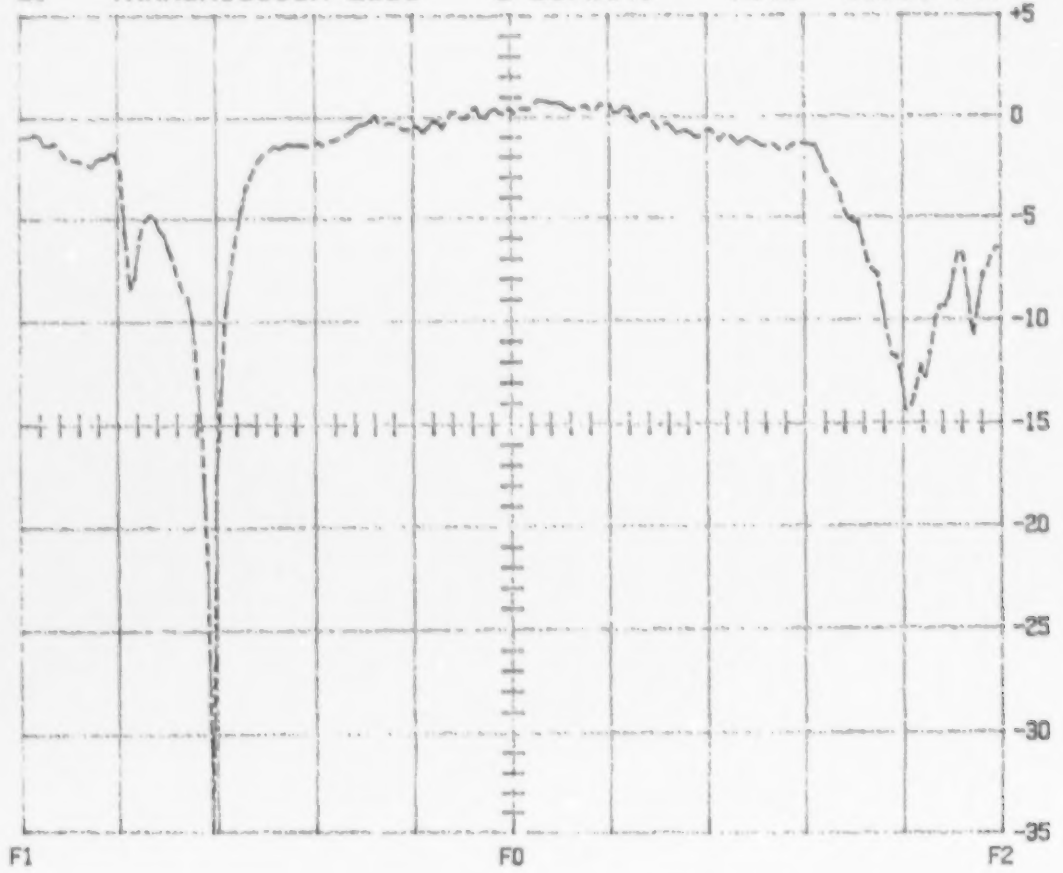
MODEL #: LHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-56.96 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - - -

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.16

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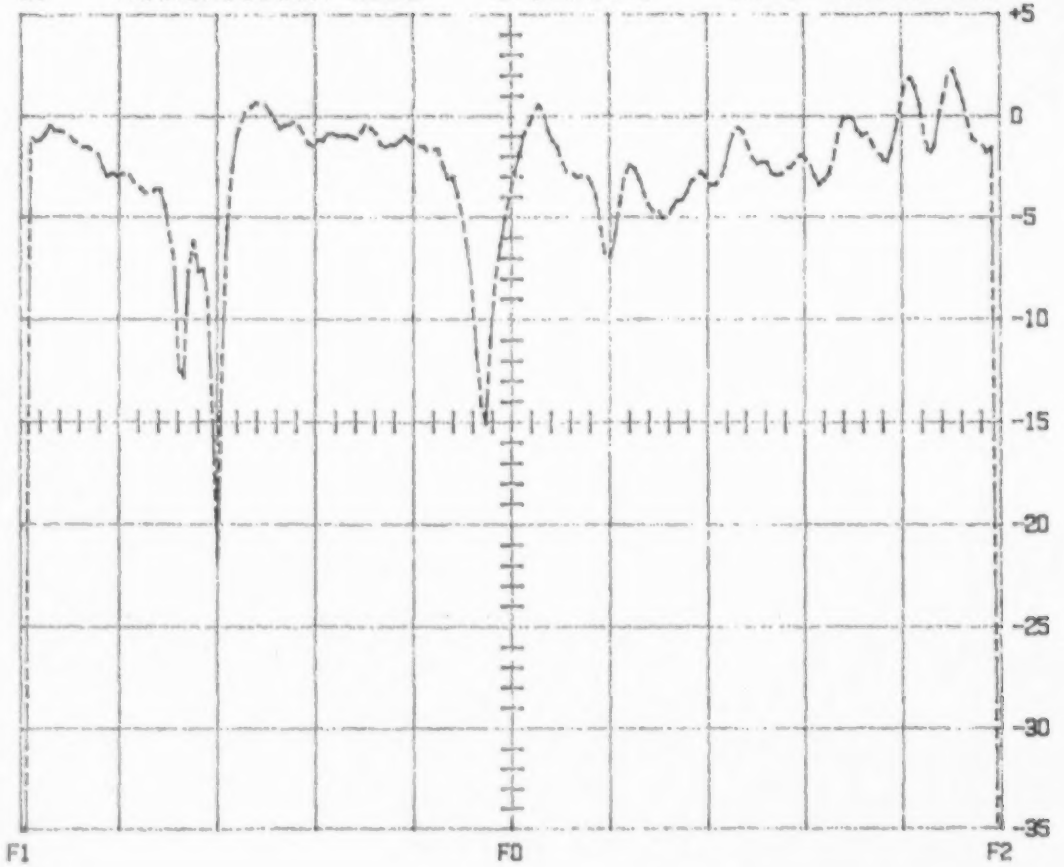
MODEL #: LHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.40 DB.



(DB.)

(FREQUENCY)

DATE: 06-27-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: - - - - - -

F0 : 9375 MHZ.
F1 : 3750 MHZ.
F2 : 15000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure 4.2.17

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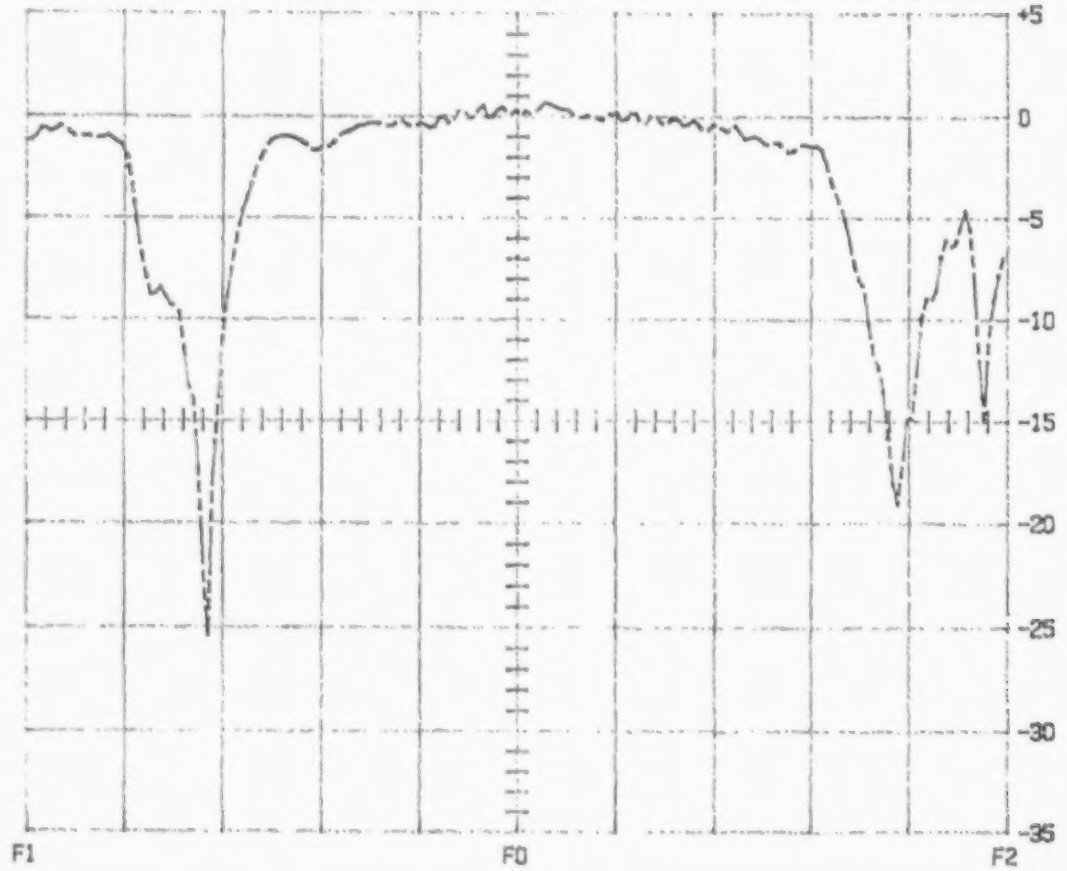
MODEL #: LHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. = -58.54 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D. A. T.
APPROVED:

RETURN LOSS: ----------
TRANS. LOSS: ----------

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.18

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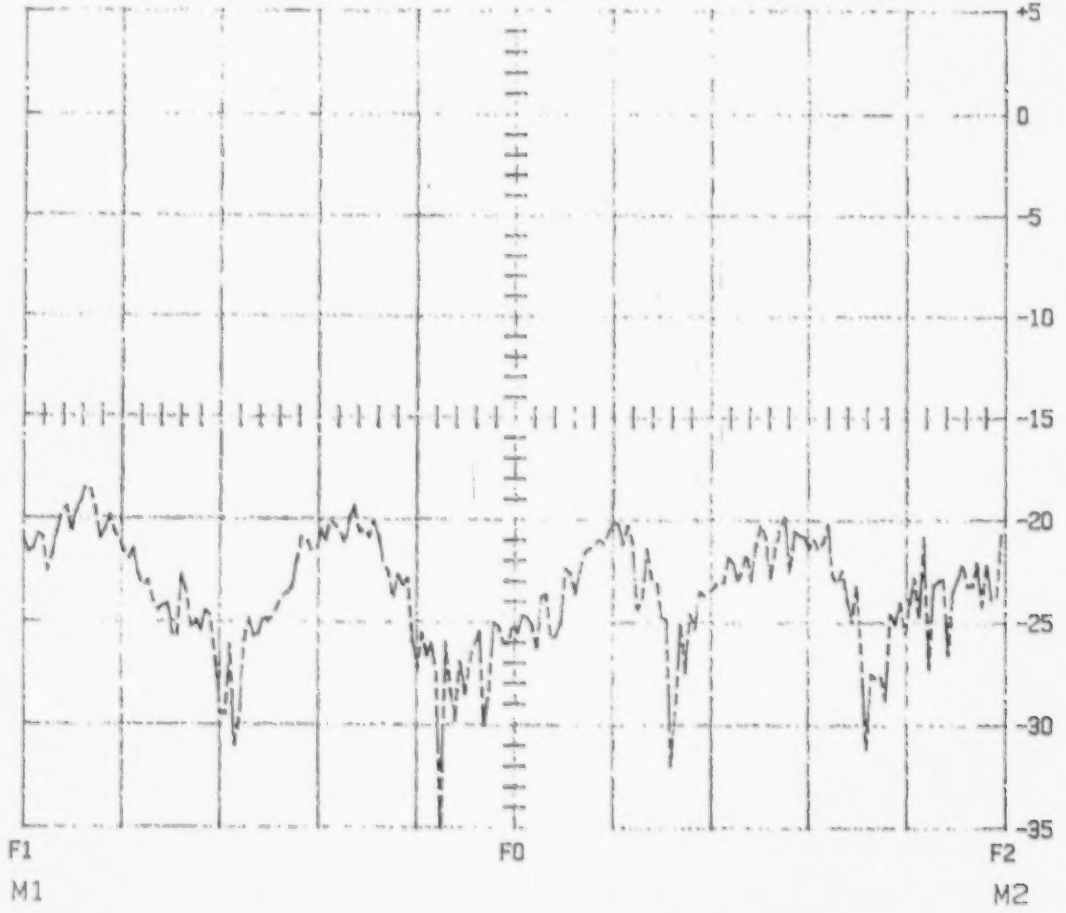
MODEL #: RHCPATTENUATION DUE TO PLATE 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.44 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ------
TRANS. LOSS: ------

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.19

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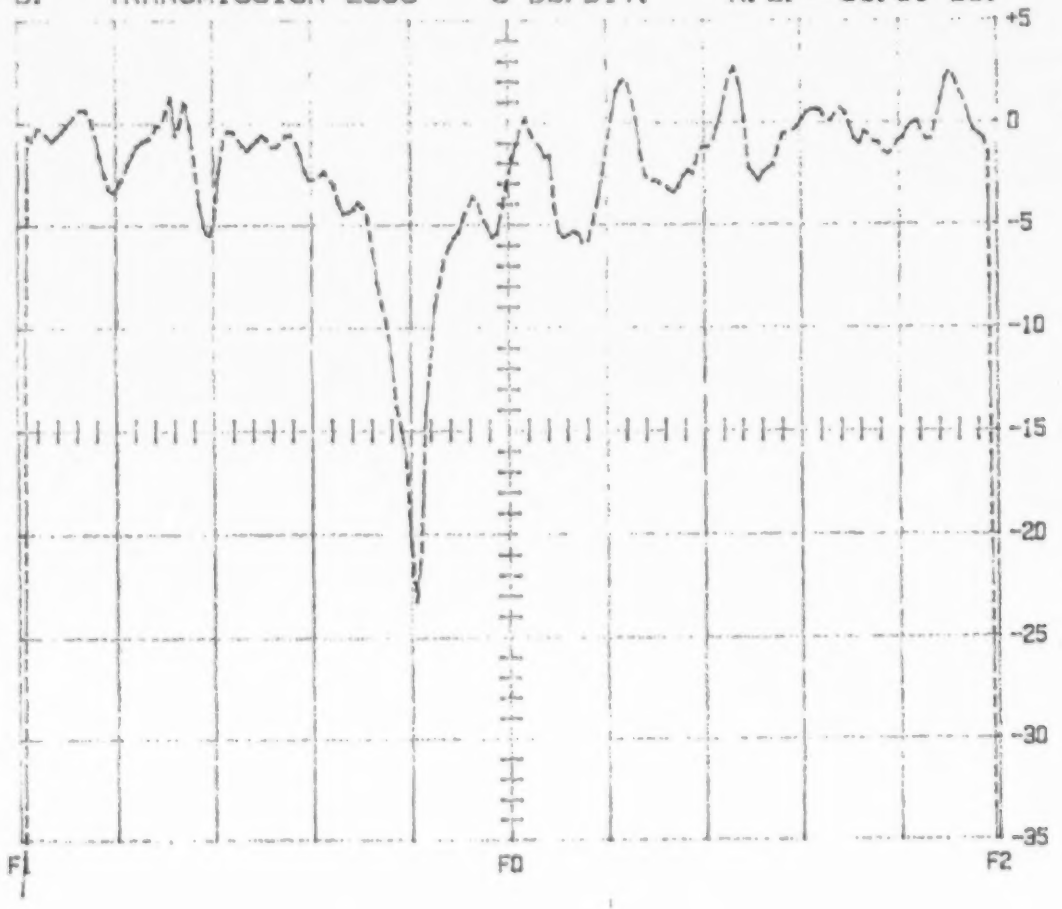
MODEL #: RHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.31 DB.



DATE: 06-27-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - -
TRANS. LOSS: ———

F0 : 9375 MHZ.
F1 : 3750 MHZ.
F2 : 15000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure 4.2.20

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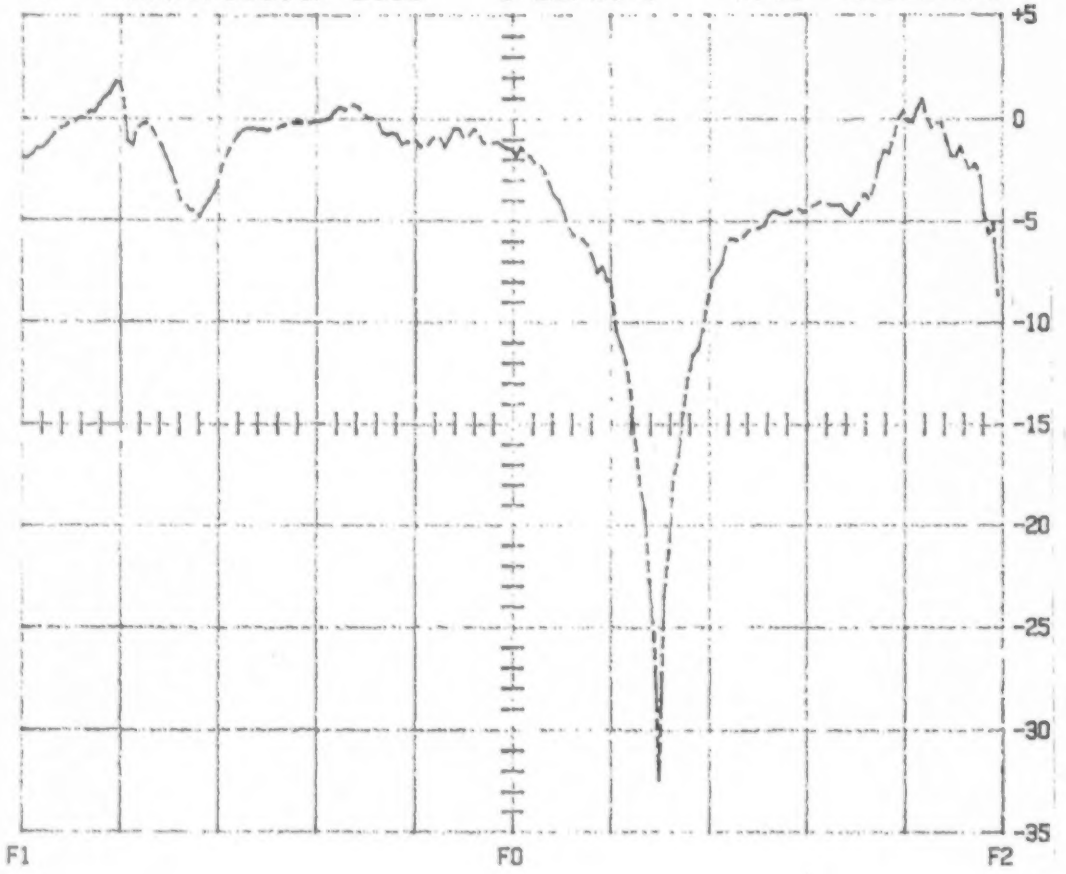
MODEL #: RHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-55.69 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ------
TRANS. LOSS: ------

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.21

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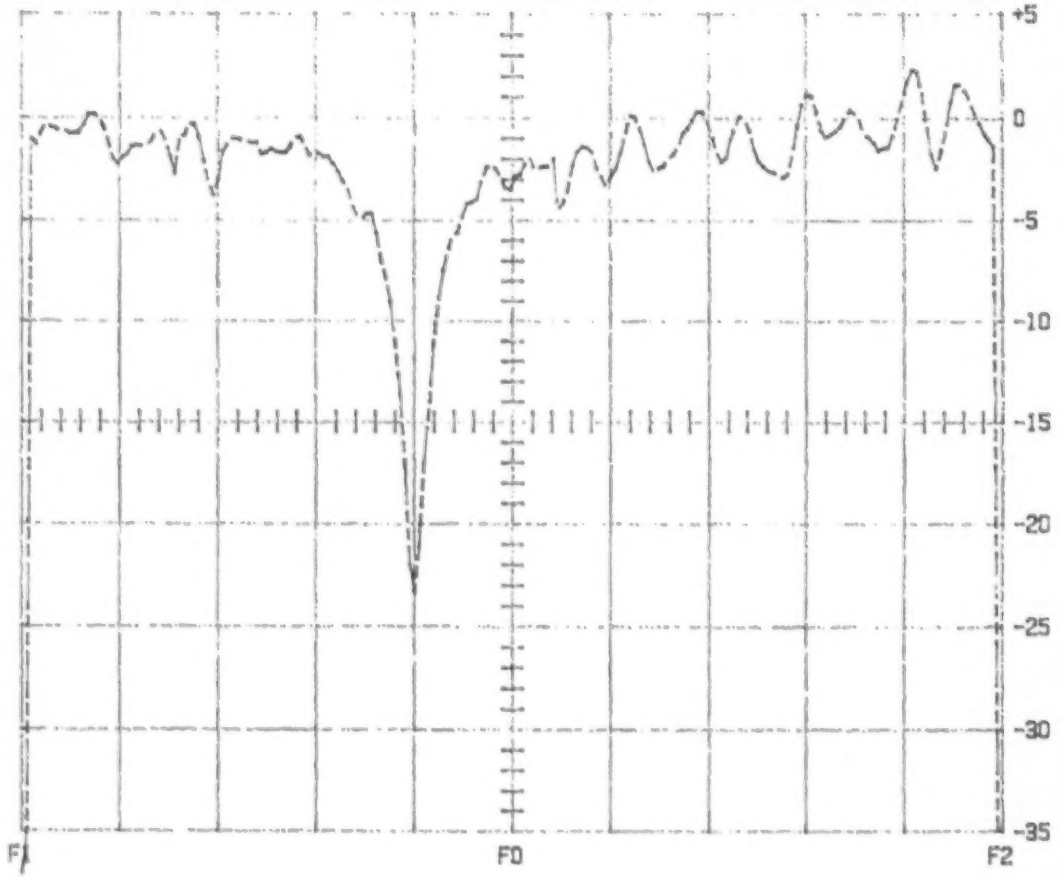
MODEL #: RHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.29 DB.



DATE: 06-27-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - -
TRANS. LOSS: ————

F0 : 9375 MHZ.
F1 : 3750 MHZ.
F2 : 15000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure 4.2.22

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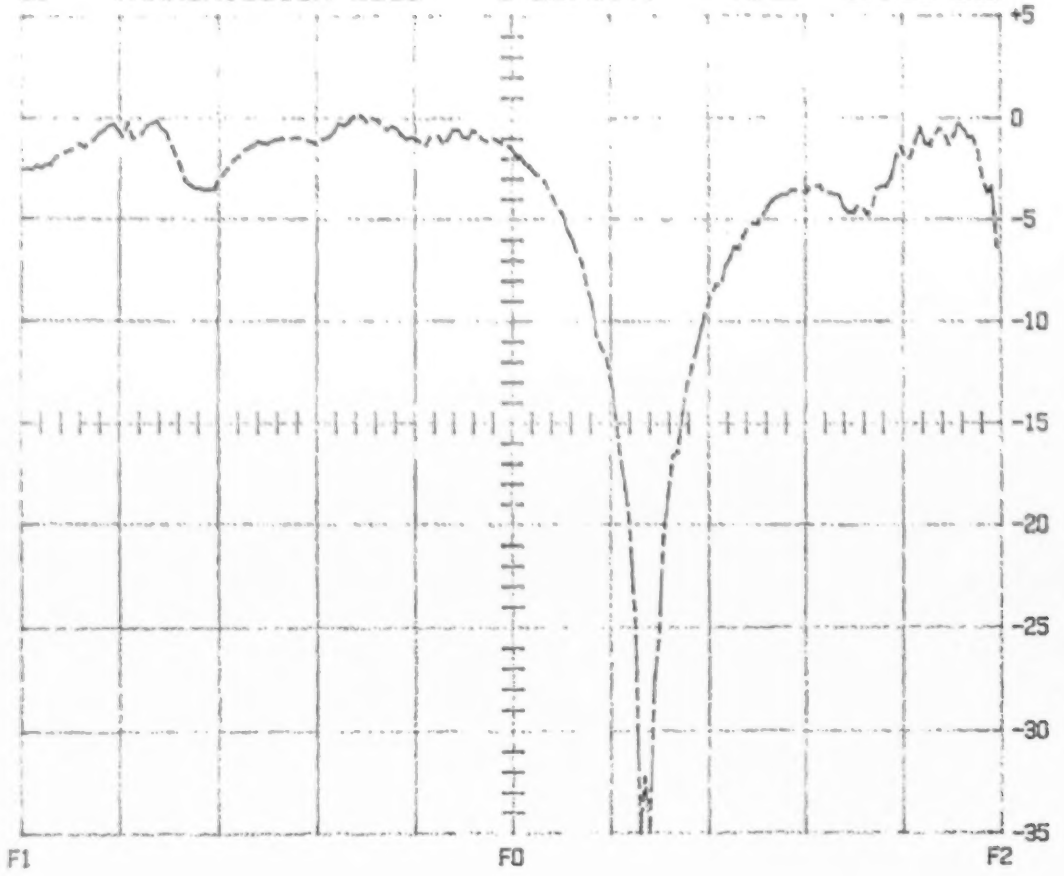
MODEL #: RHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-57.36 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: ———

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.23

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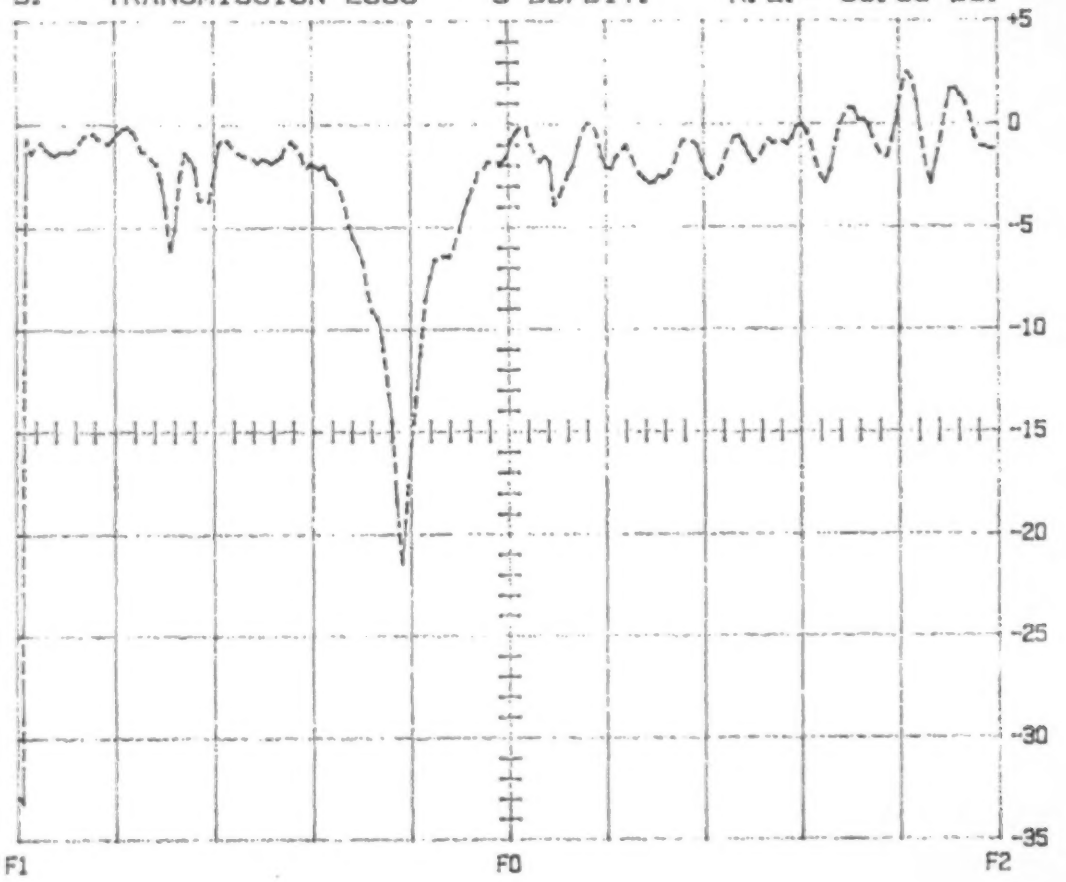
MODEL #: RHCP ATTENUATION DUE TO PSS 30 DEG.



DATE: 06-27-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - - - -
TRANS. LOSS: ———

F0 : 9375 MHZ.
F1 : 3750 MHZ.
F2 : 15000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure 4.2.24

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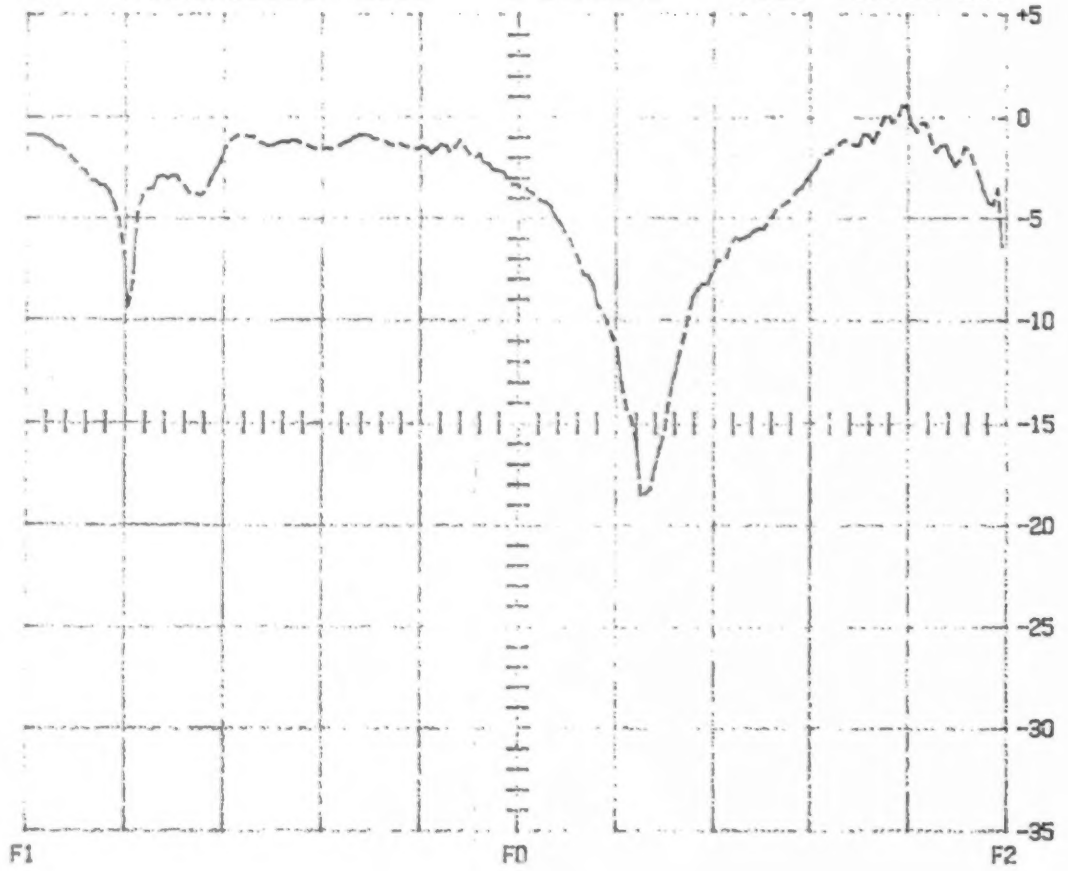
MODEL #: RHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-57.51 DB.



(DB.)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ----
TRANS. LOSS: ------

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.25

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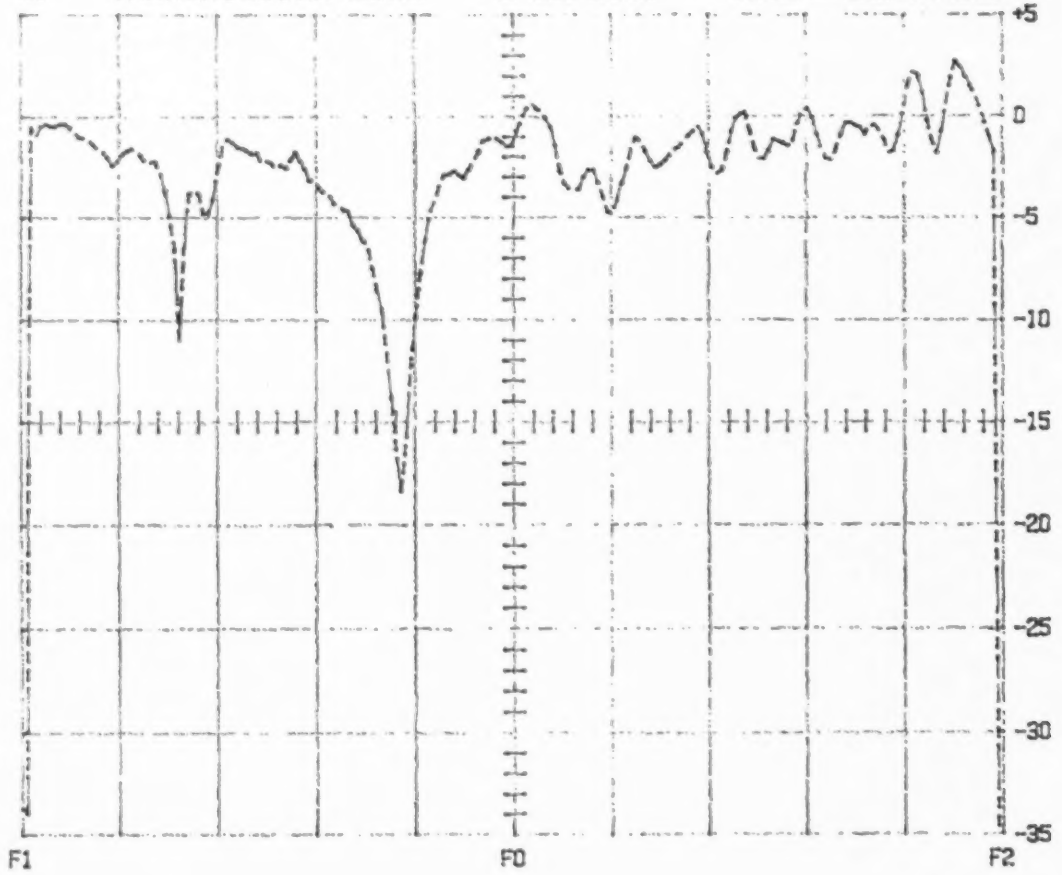
MODEL #: RHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.44 DB.



(DB.)

(FREQUENCY)

DATE: 06-27-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - - - -
TRANS. LOSS: ———————

F0 : 9375 MHZ.
F1 : 3750 MHZ.
F2 : 15000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure 4.2.26

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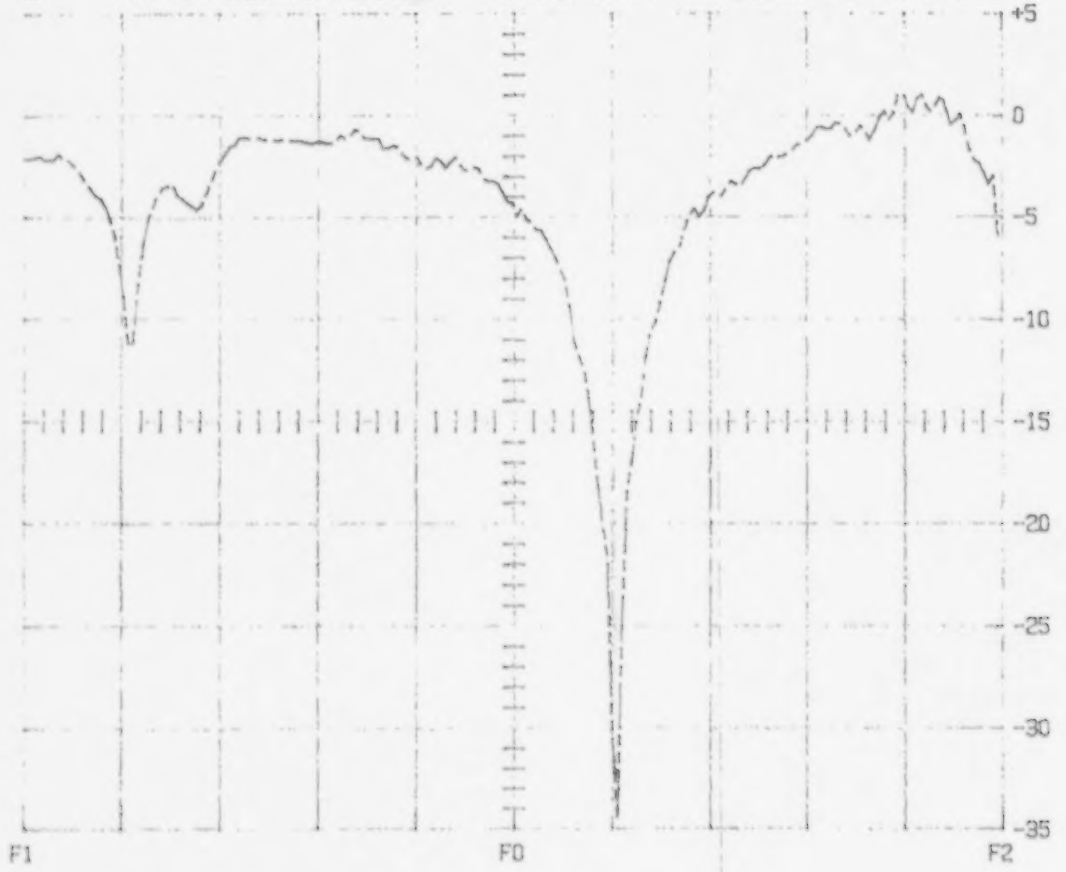
MODEL #: RHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-57.27 DB.



(DB)

(FREQUENCY)

DATE: 06-06-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: - - - - -

F0 : 7500 MHZ.
F1 : 5000 MHZ.
F2 : 10000 MHZ.

M1 :
M2 :

POWER LEVEL : 10 DBM.

Figure # 4.2.27

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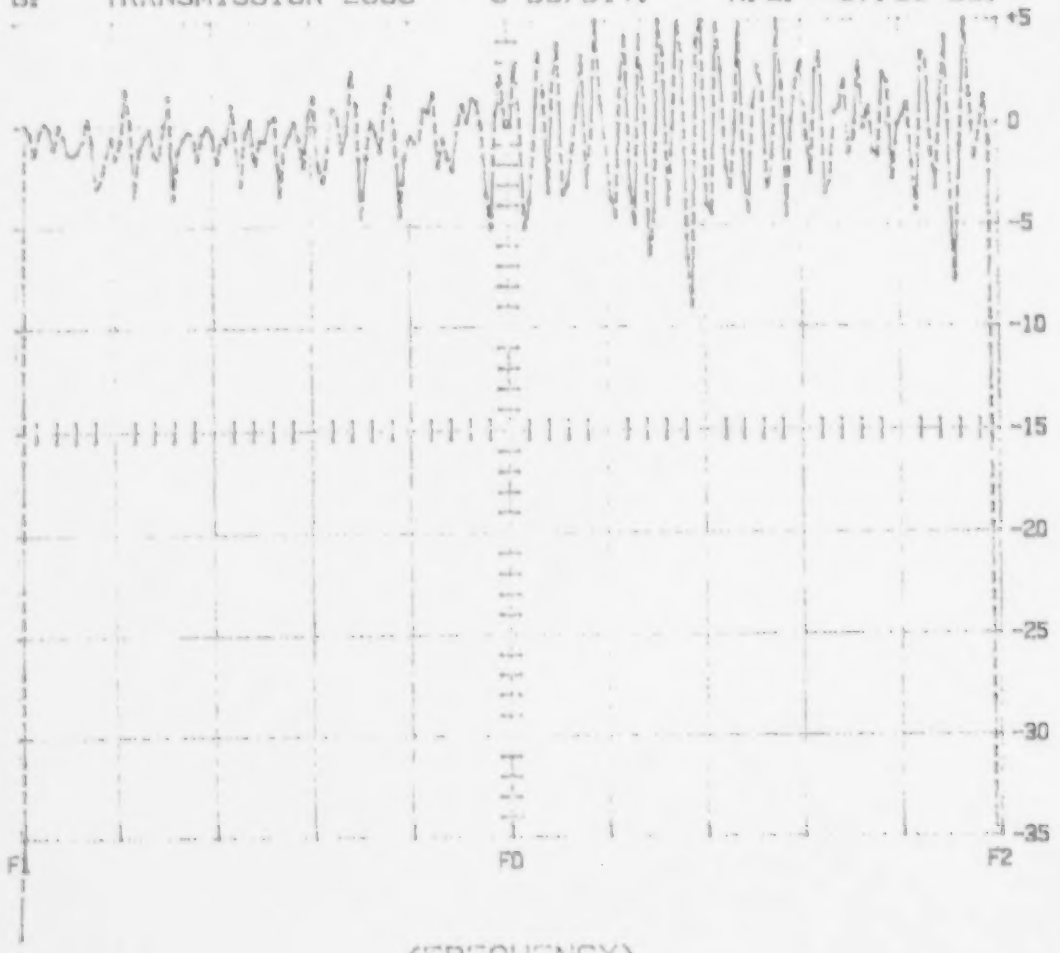
MODEL #: TRANSMISSION THROUGH 1/8" DIELECTRIC

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. = -57.06 DB.



DATE: 29-09
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: - - - - -

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.3.1

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MODEL #: TRANSMISSION THROUGH 1/8" DIELECTRI

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-57.84 DB.

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - - -

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.3.2

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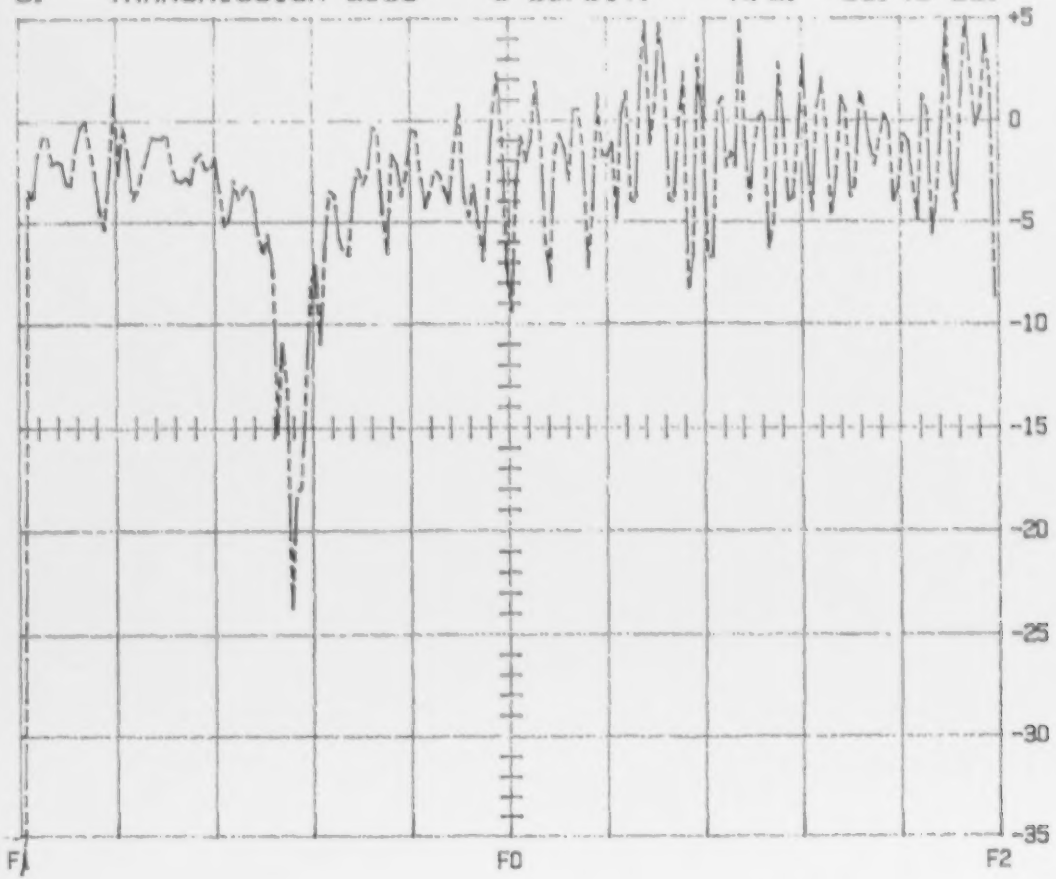
MODEL #: LHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.40 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - - -
TRANS. LOSS: ———

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.3

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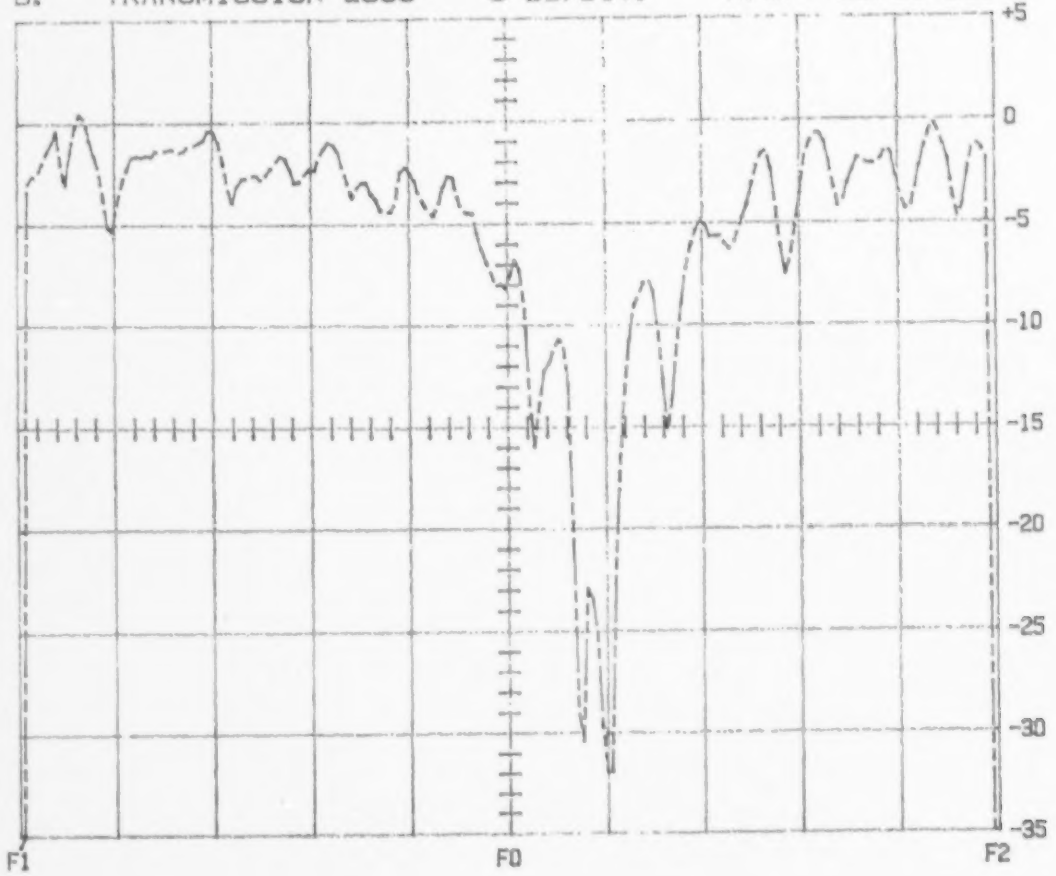
MODEL #: LHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-56.80 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - -
TRANS. LOSS: ——————

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.4

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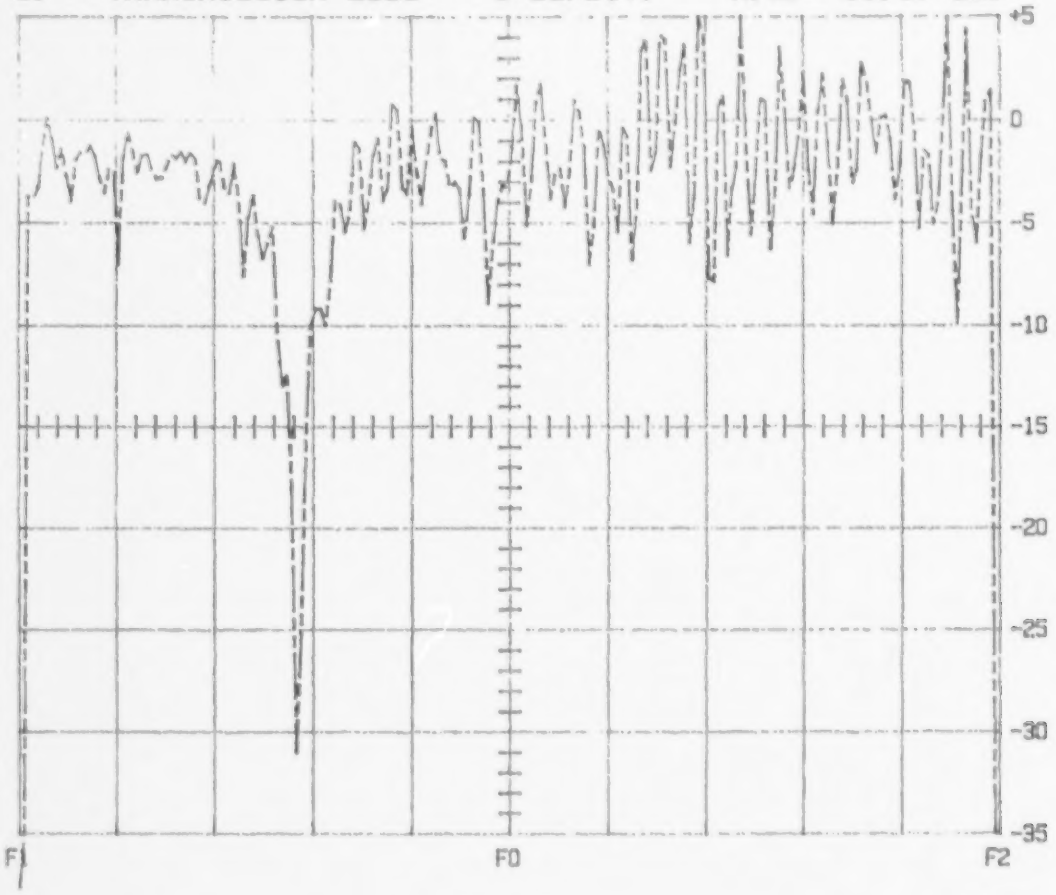
MODEL #: LHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-55.87 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ----------
TRANS. LOSS: ——————

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.5

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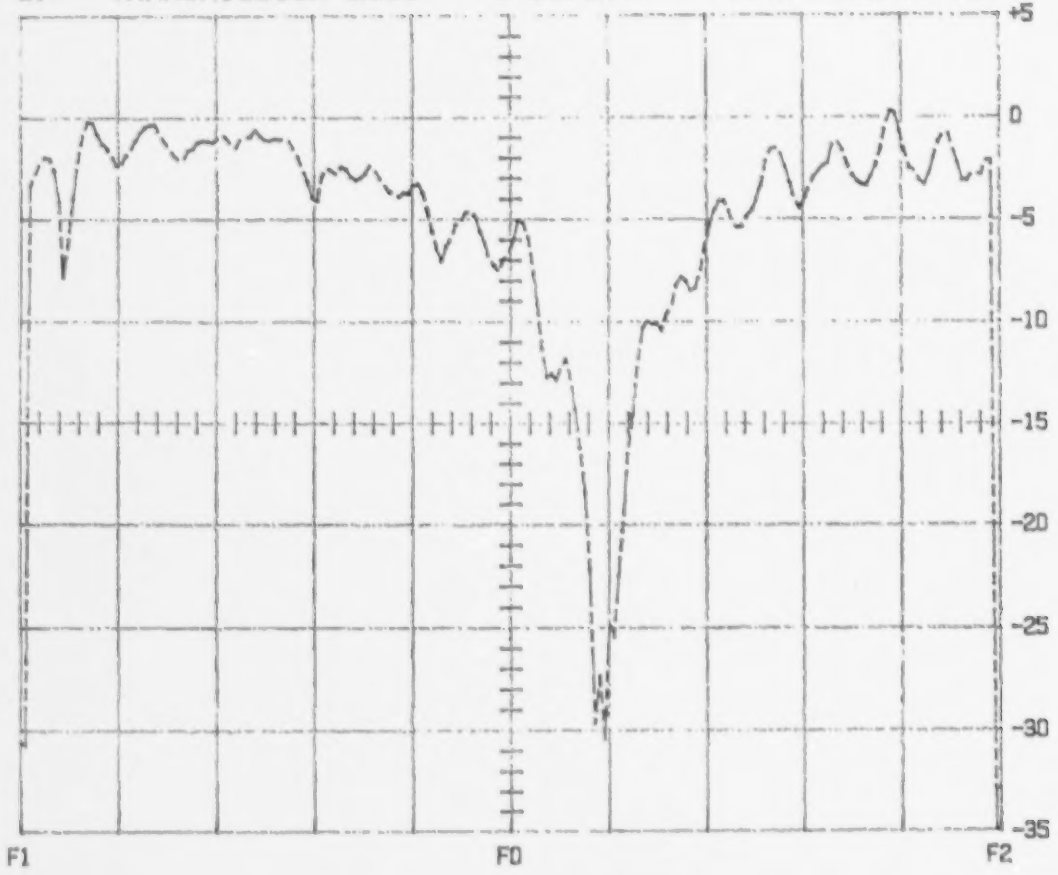
MODEL #: LHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-56.07 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: — — — —
TRANS. LOSS: ——————

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.6

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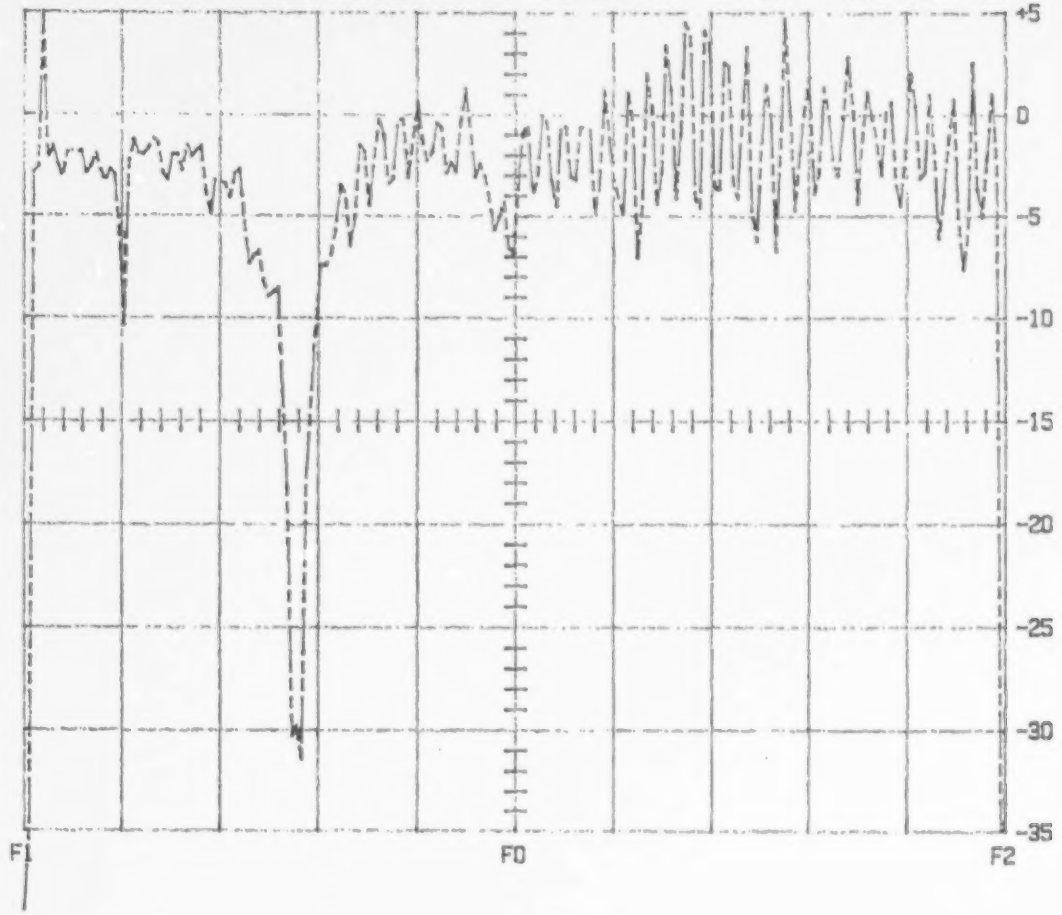
MODEL #: LHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF

B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-52.44 DB.



DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - - - -
TRANS. LOSS: ———————

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.7

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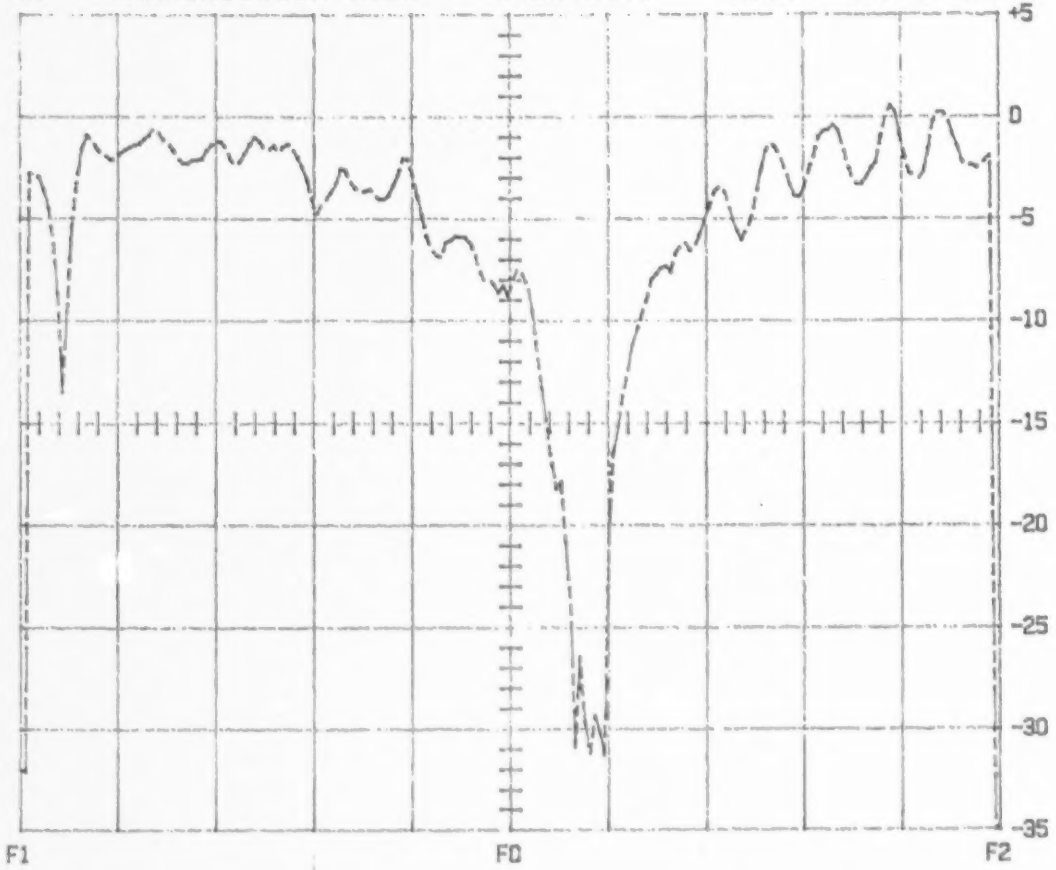
MODEL #: LHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-55.23 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ----
TRANS. LOSS: ------

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.8

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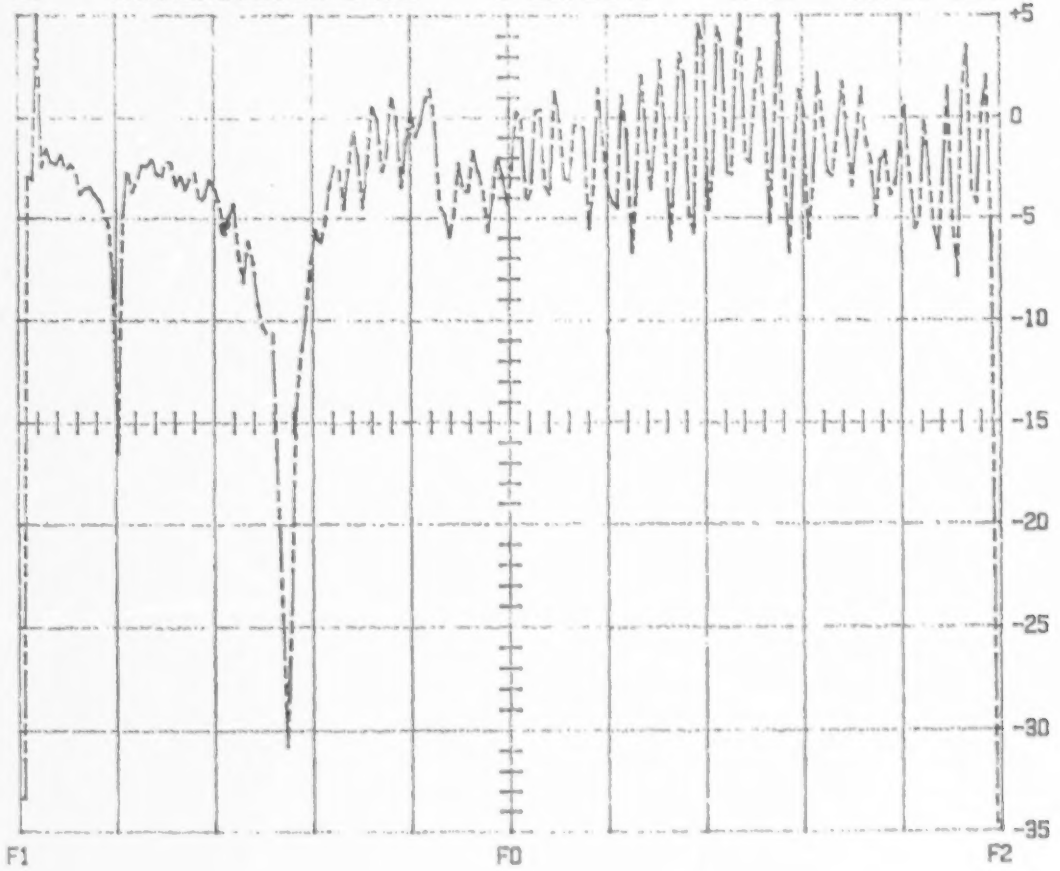
MODEL #: LHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.31 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D. A. T.
APPROVED:

RETURN LOSS: - - - - -
TRANS. LOSS: ———

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.9

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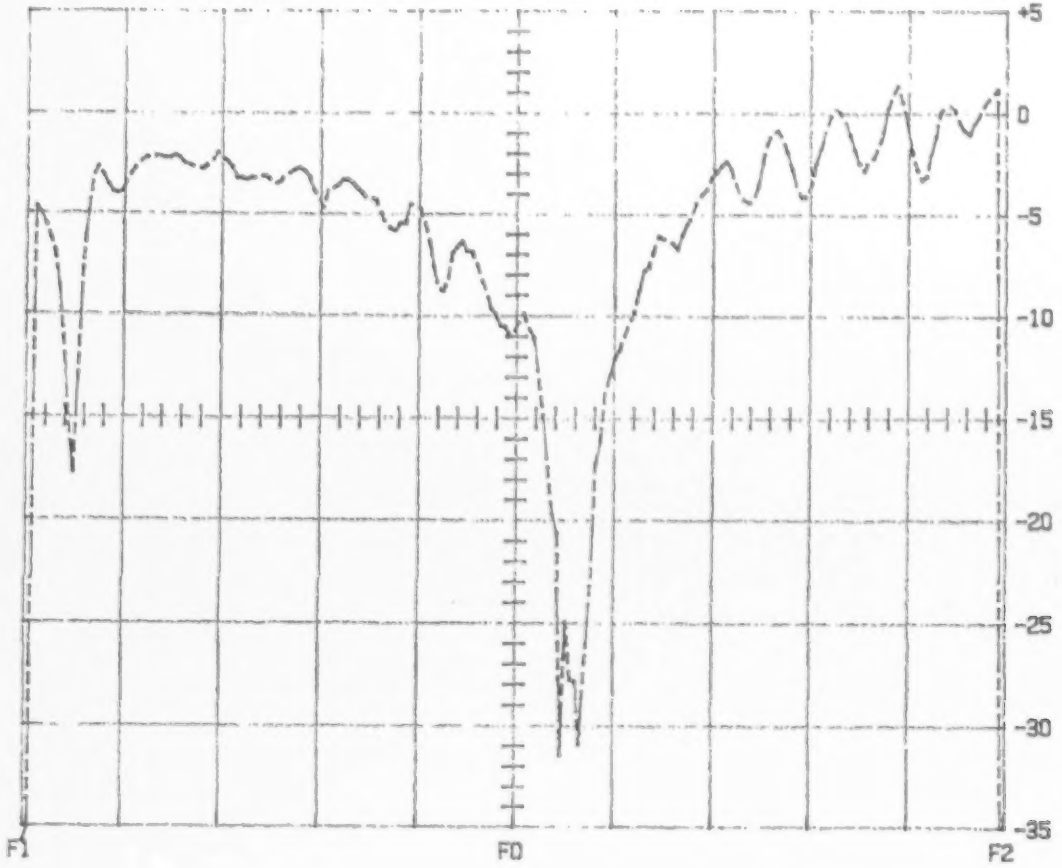
MODEL #: LHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.29 DB.



DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: — ——
TRANS. LOSS: ——————

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.10

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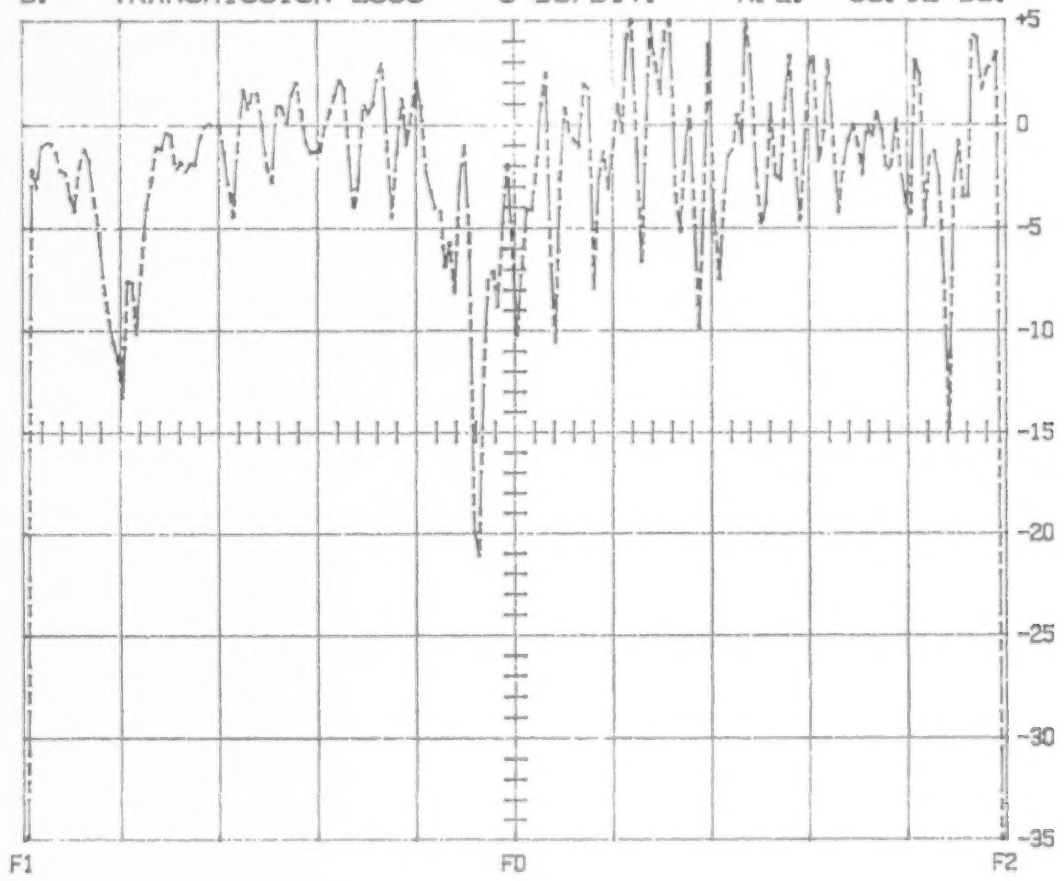
MODEL #: RHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF

B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.12 DB.



DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

(DB.)

(FREQUENCY)

RETURN LOSS: ——·——·——
TRANS. LOSS: ————————

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.11

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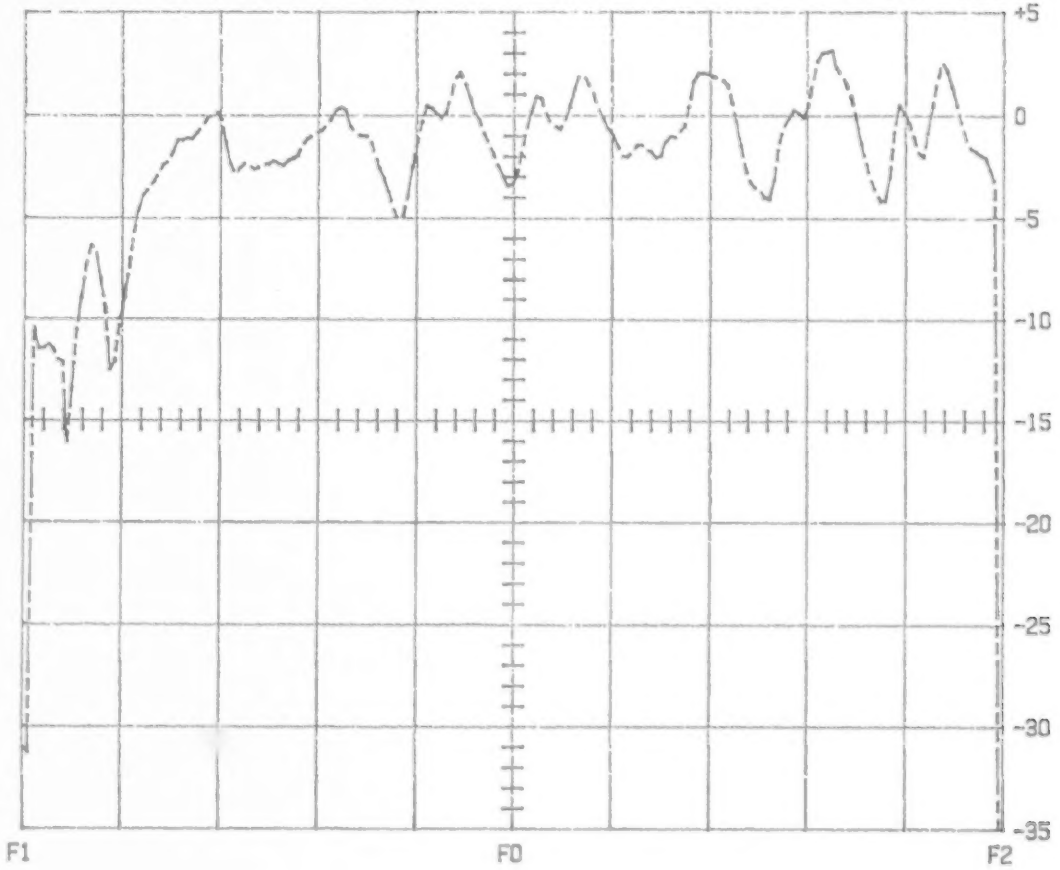
MODEL #: RHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.59 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ——·——·——
TRANS. LOSS: ——————

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.12

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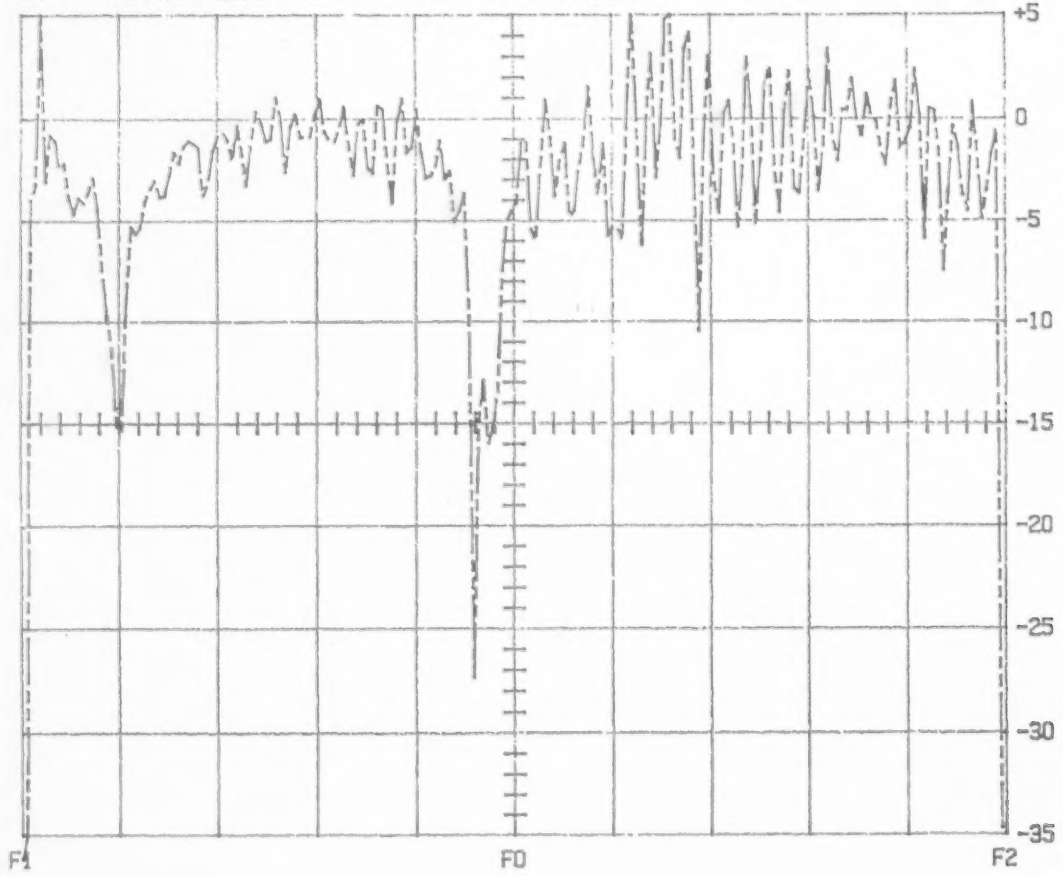
MODEL #: RHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-57.52 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: — - - - -
TRANS. LOSS: ——————

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.13

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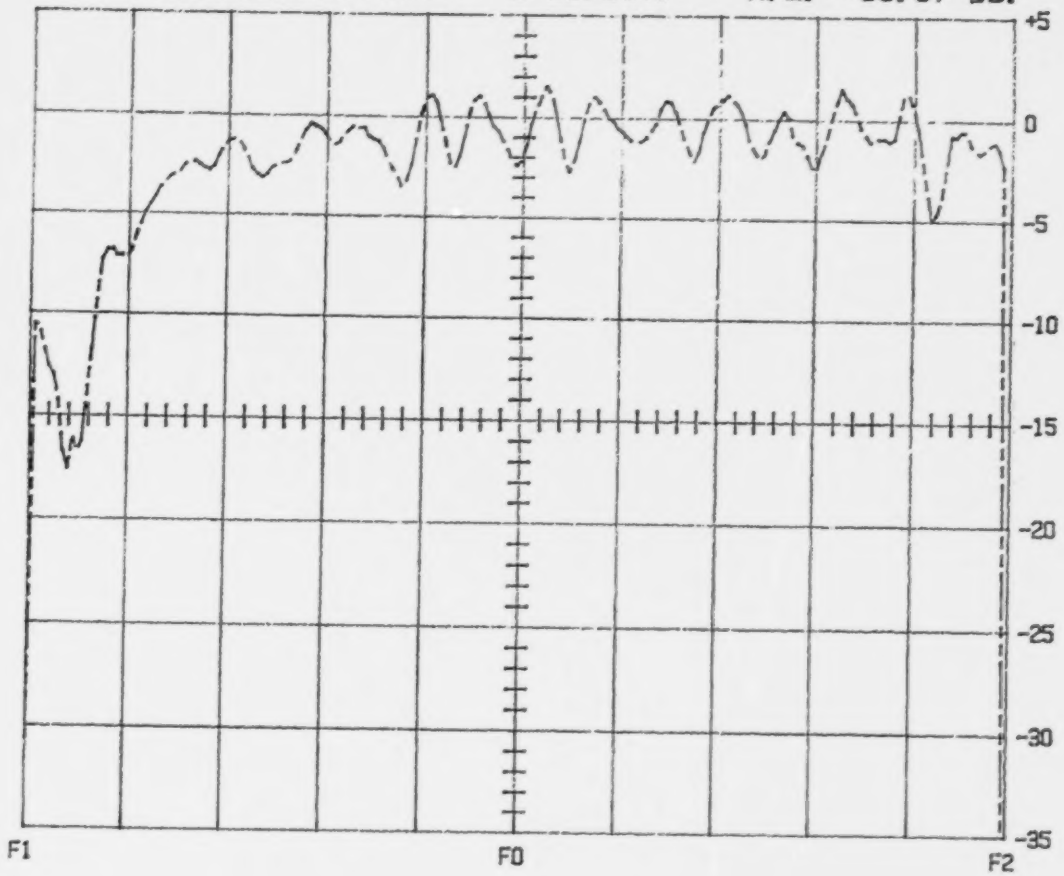
MODEL #: RHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-55.67 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - - - -
TRANS. LOSS: ——— ———

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.14

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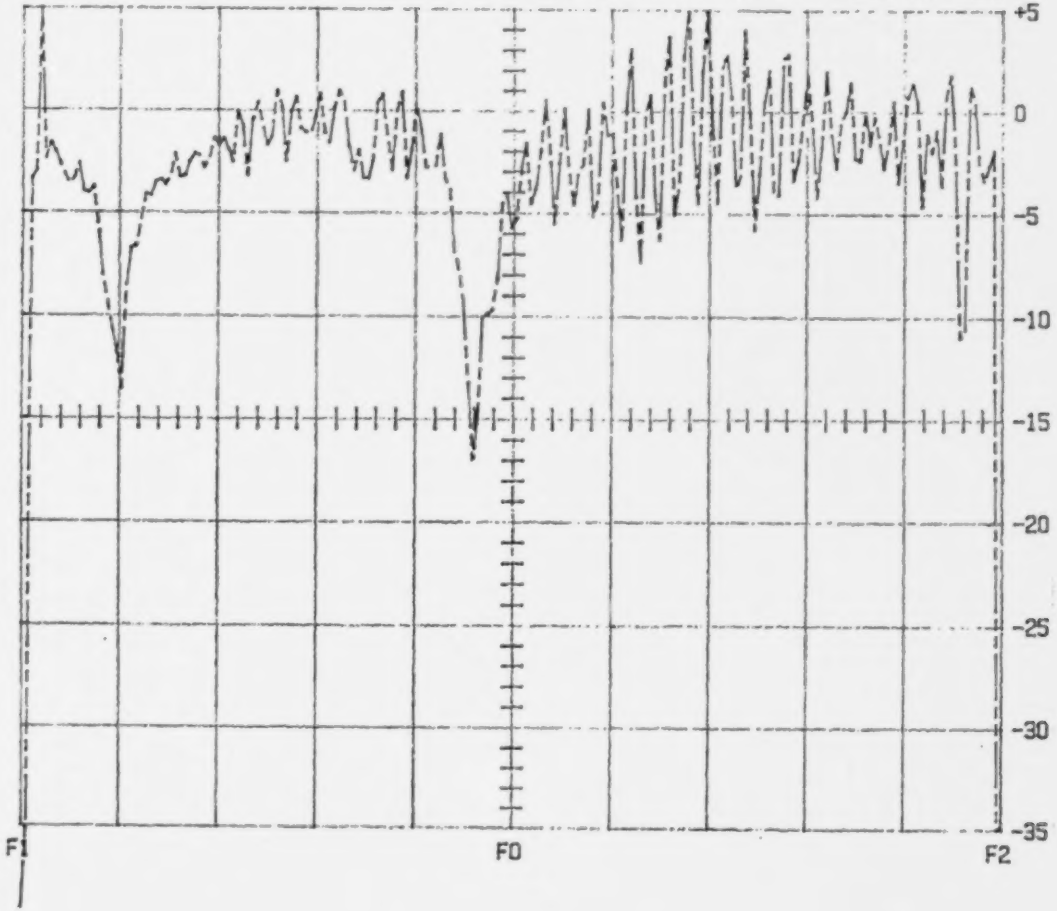
MODEL #: RHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.37 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: — - - - - -
TRANS. LOSS: ——————

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.15

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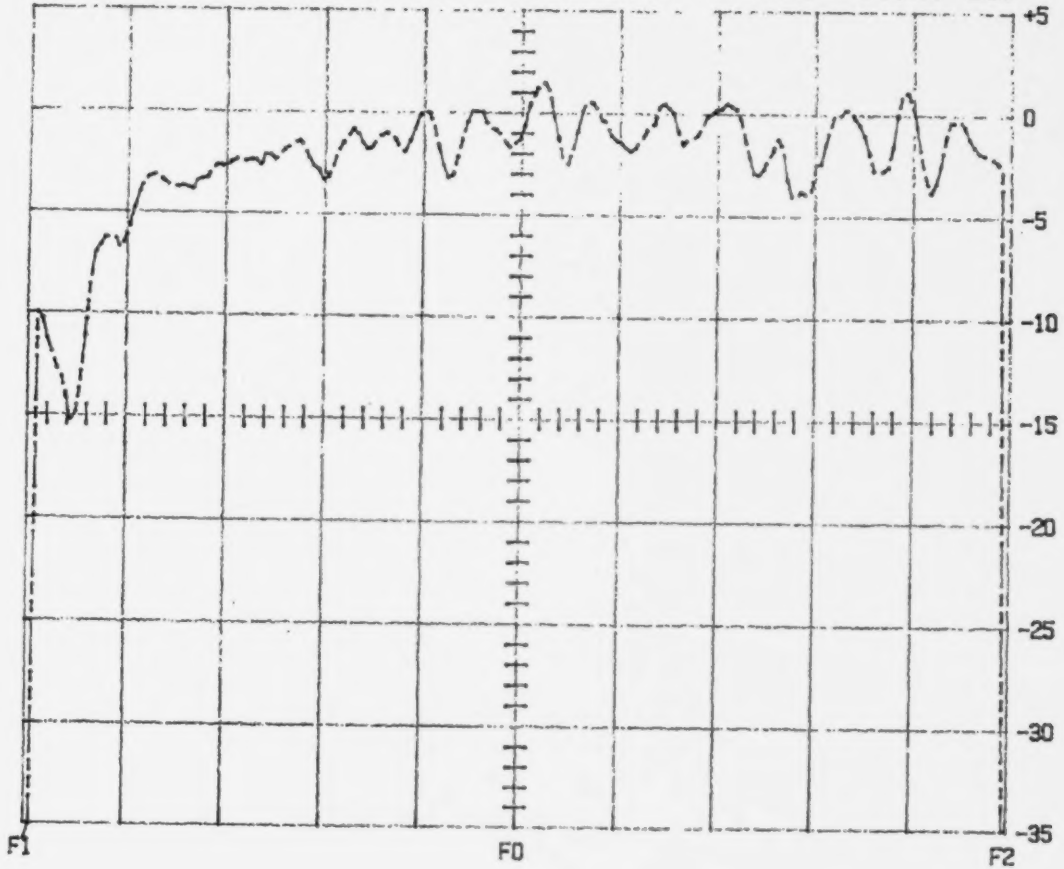
MODEL #: RHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.07 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - -
TRANS. LOSS: ------

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.10

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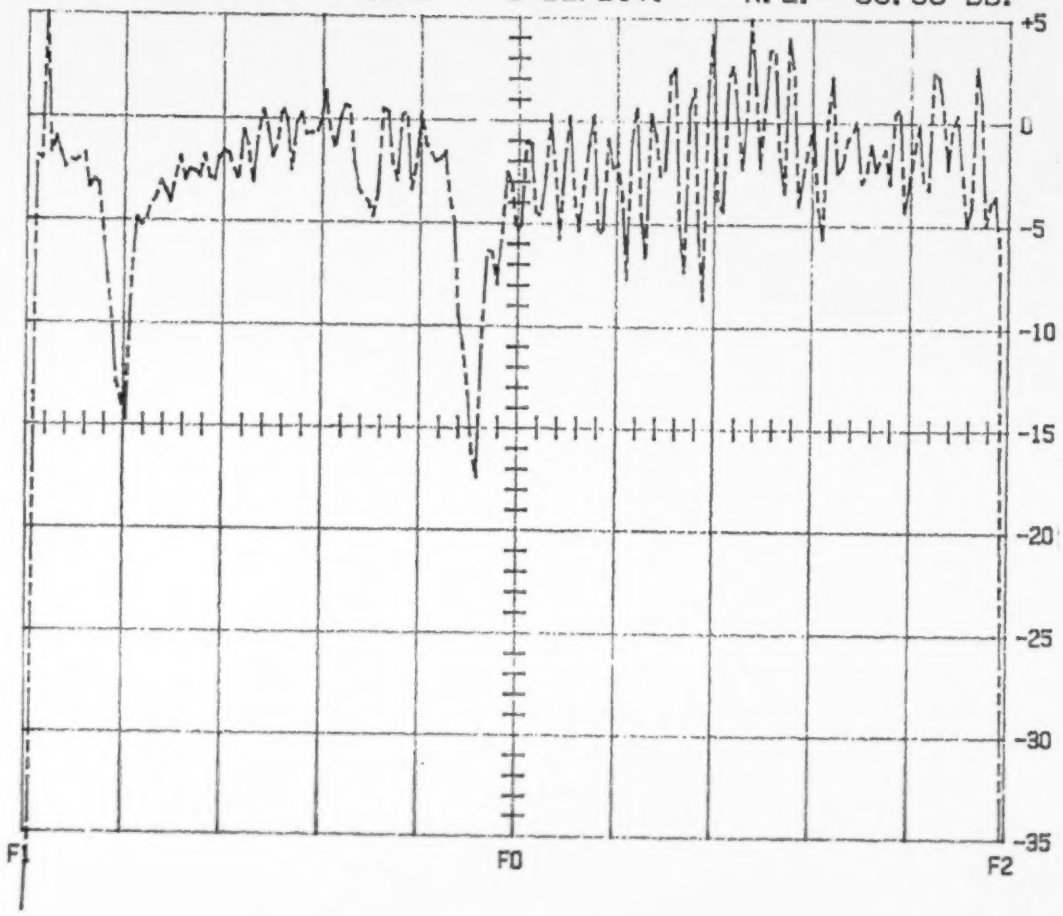
MODEL #: RHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF

B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.36 DB.



(DB.)

(FREQUENCY)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: - - - - -
TRANS. LOSS: ——————

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.17

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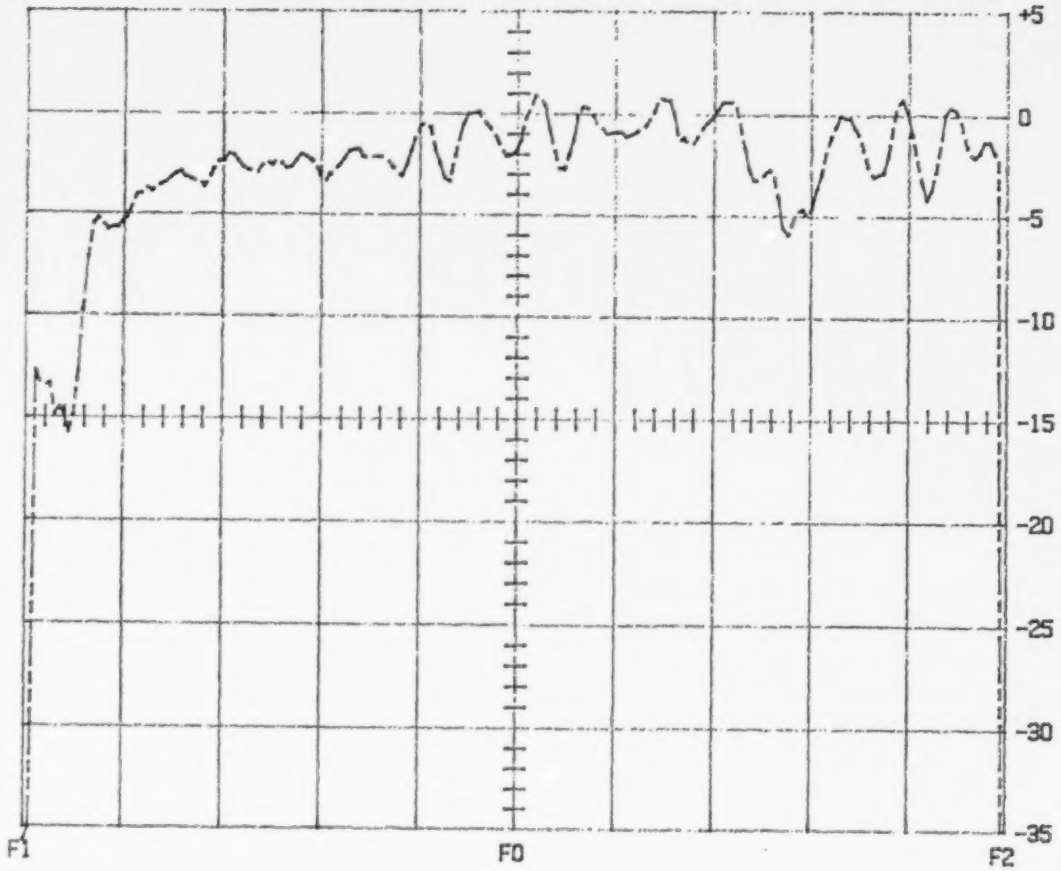
MODEL #: RHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF

B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.27 DB.



(DB.)

DATE: 20-10-89
SERIAL #: N/A
TESTED BY: D. A. T.
APPROVED:

(FREQUENCY)

RETURN LOSS: - - - - -
TRANS. LOSS: ——————

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure: 4.3.18

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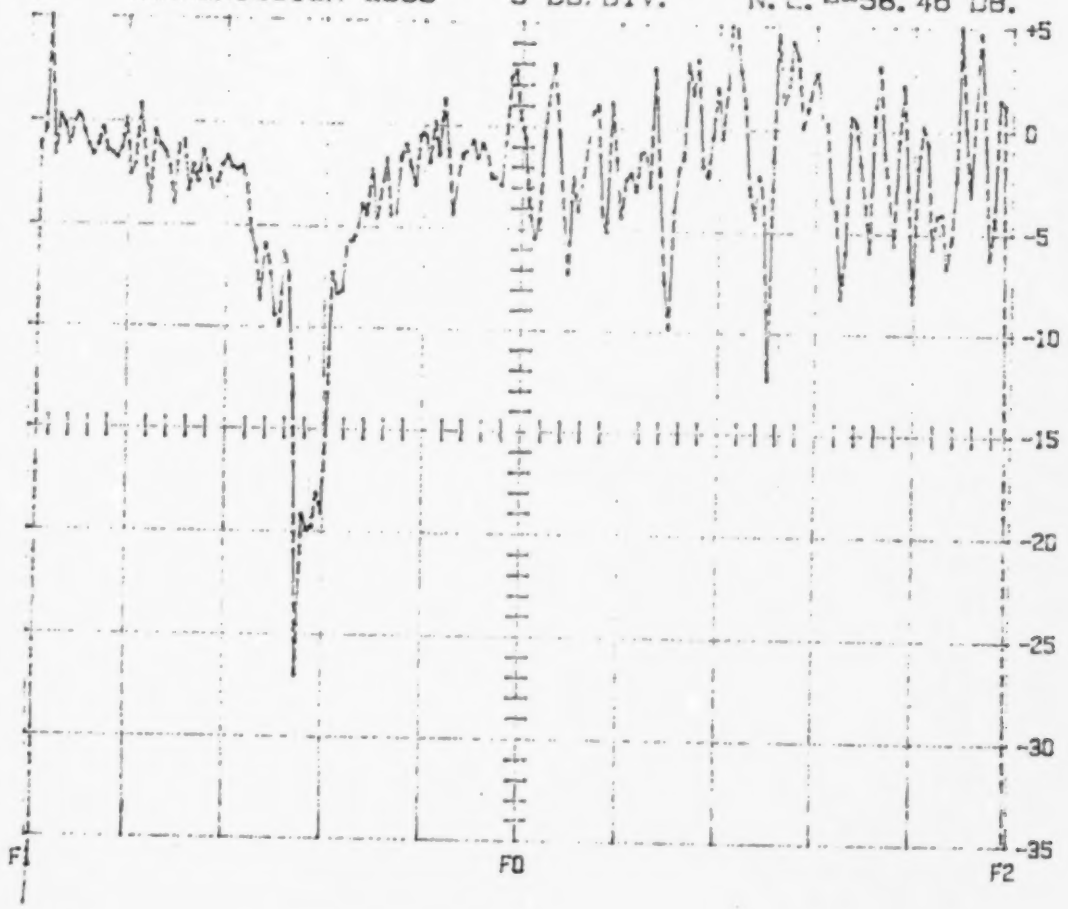
MODEL #: LHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.46 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: - - - - -

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.1

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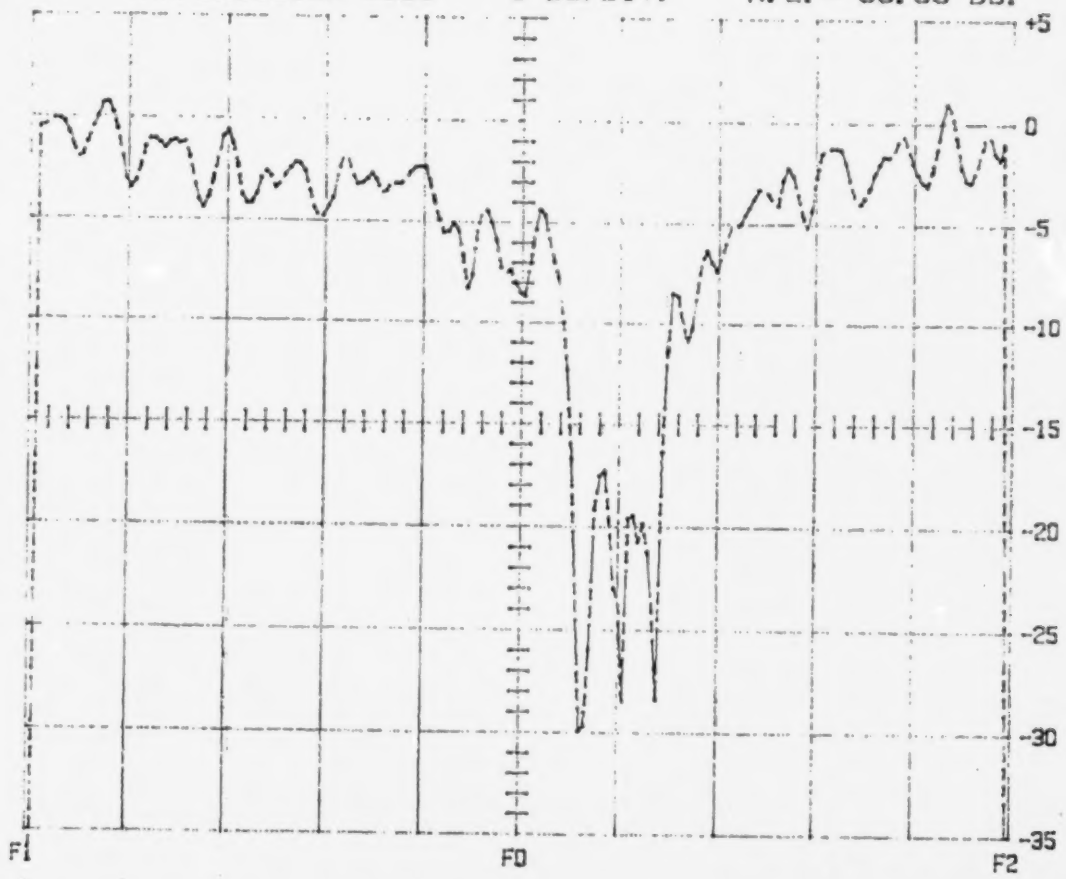
MODEL #: LHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-58.60 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: ———

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.2

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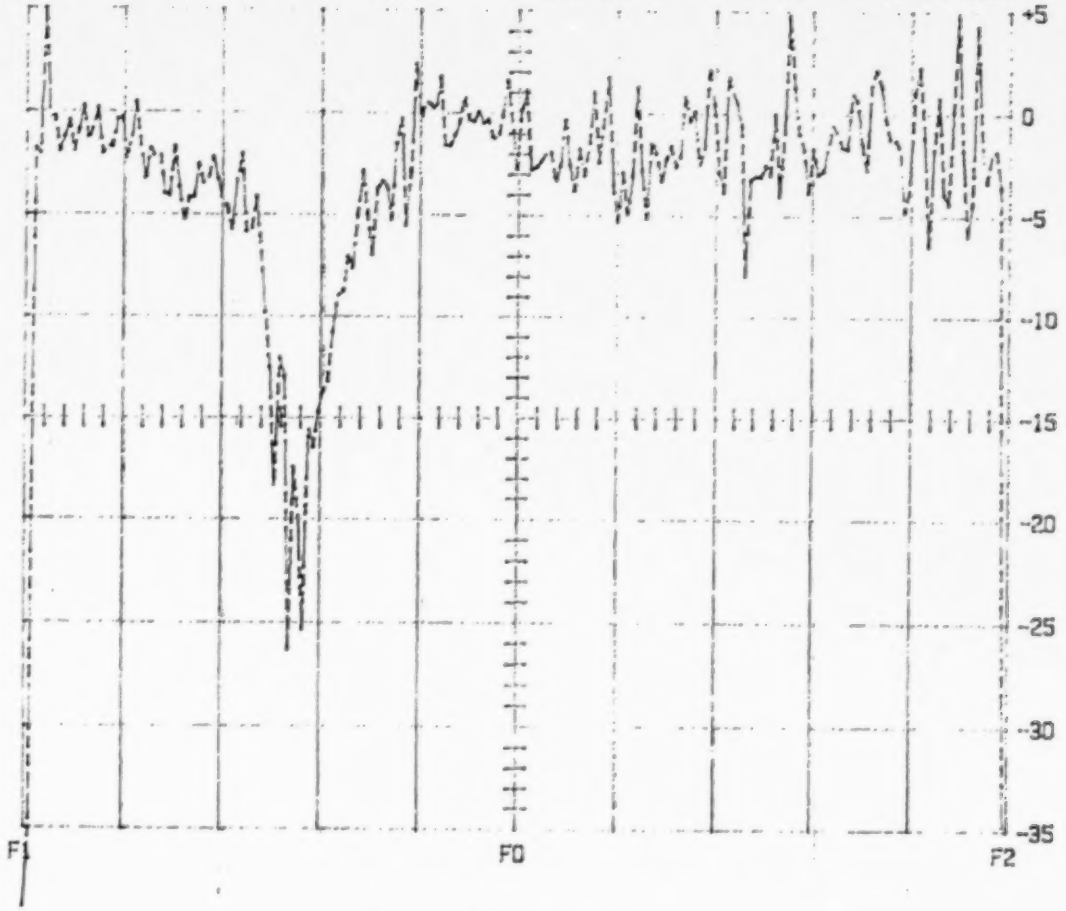
MODEL #: LHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L. =-55.30 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - - -

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.3

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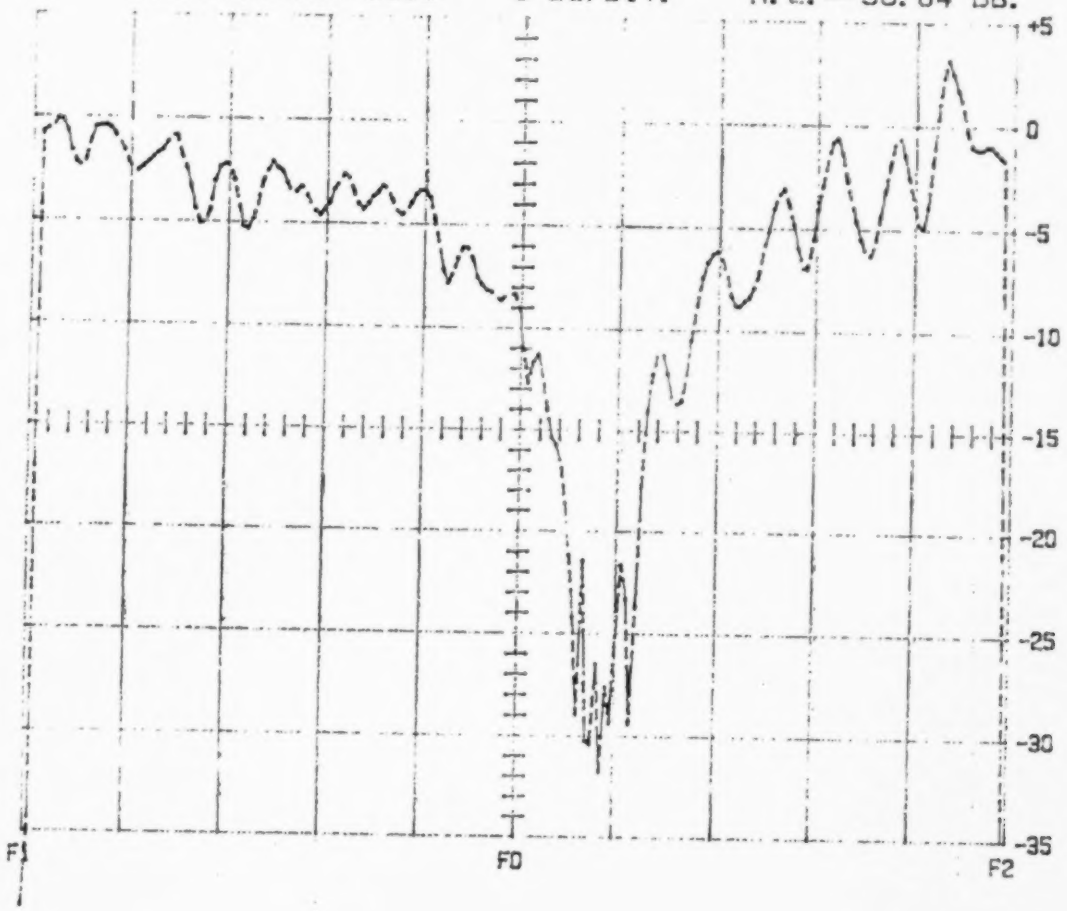
MODEL #: LHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-56.84 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: - - - - -

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.4

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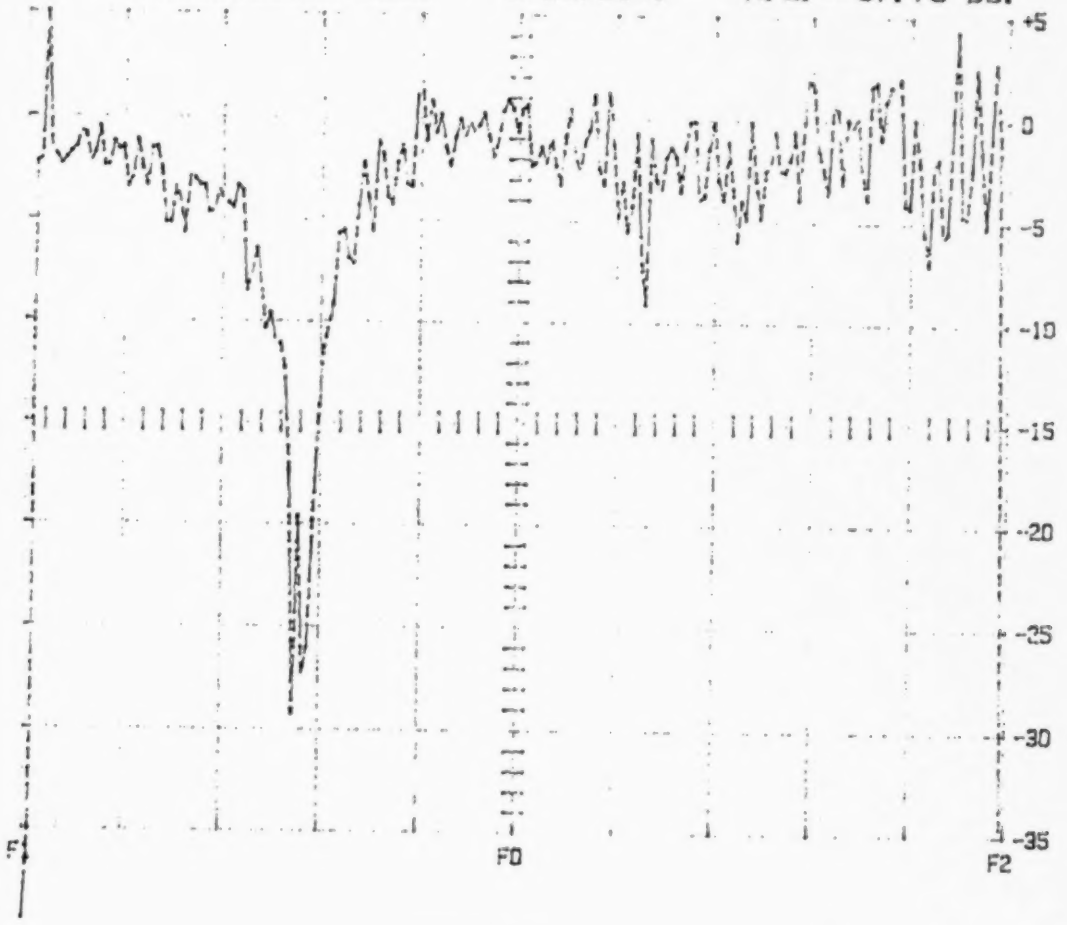
MODEL #: LHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-57.70 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: - - - - -

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL. : 11 DBM.

Figure 4.4.5

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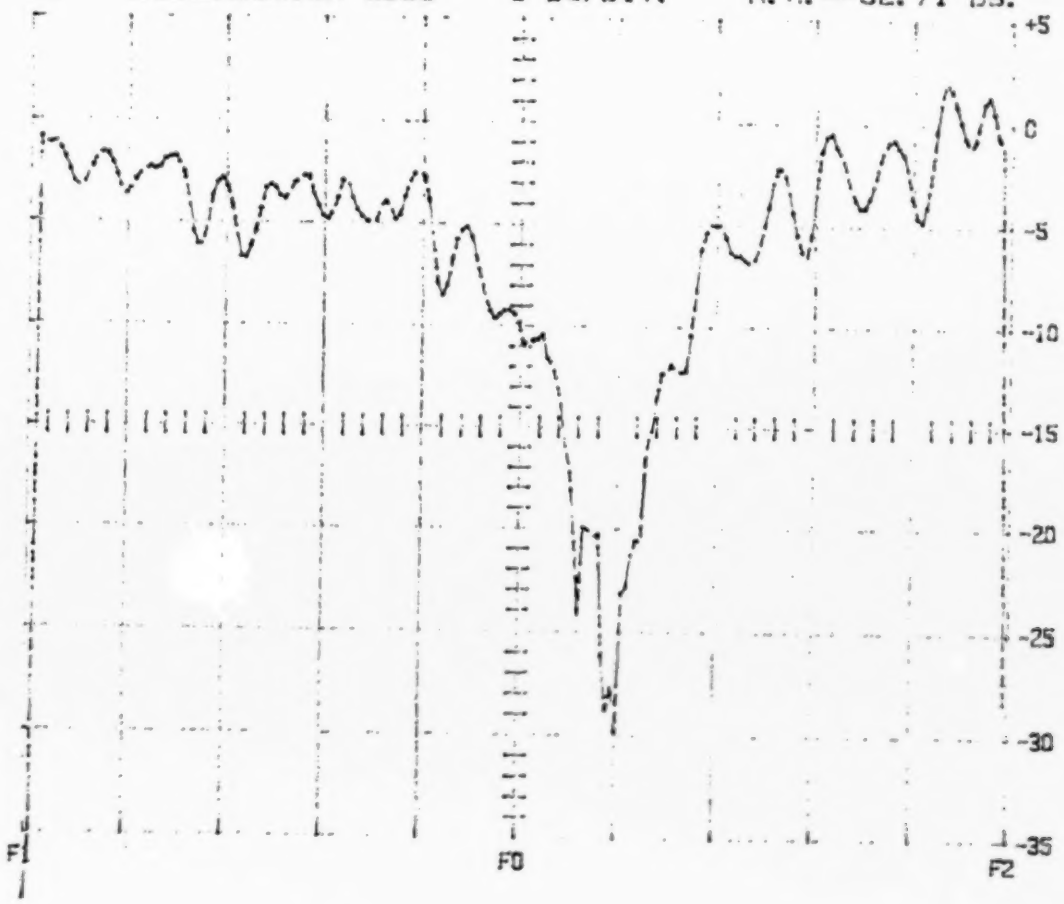
MODEL #: LHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-52.71 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ---- -----
TRANS. LOSS: --------

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.6

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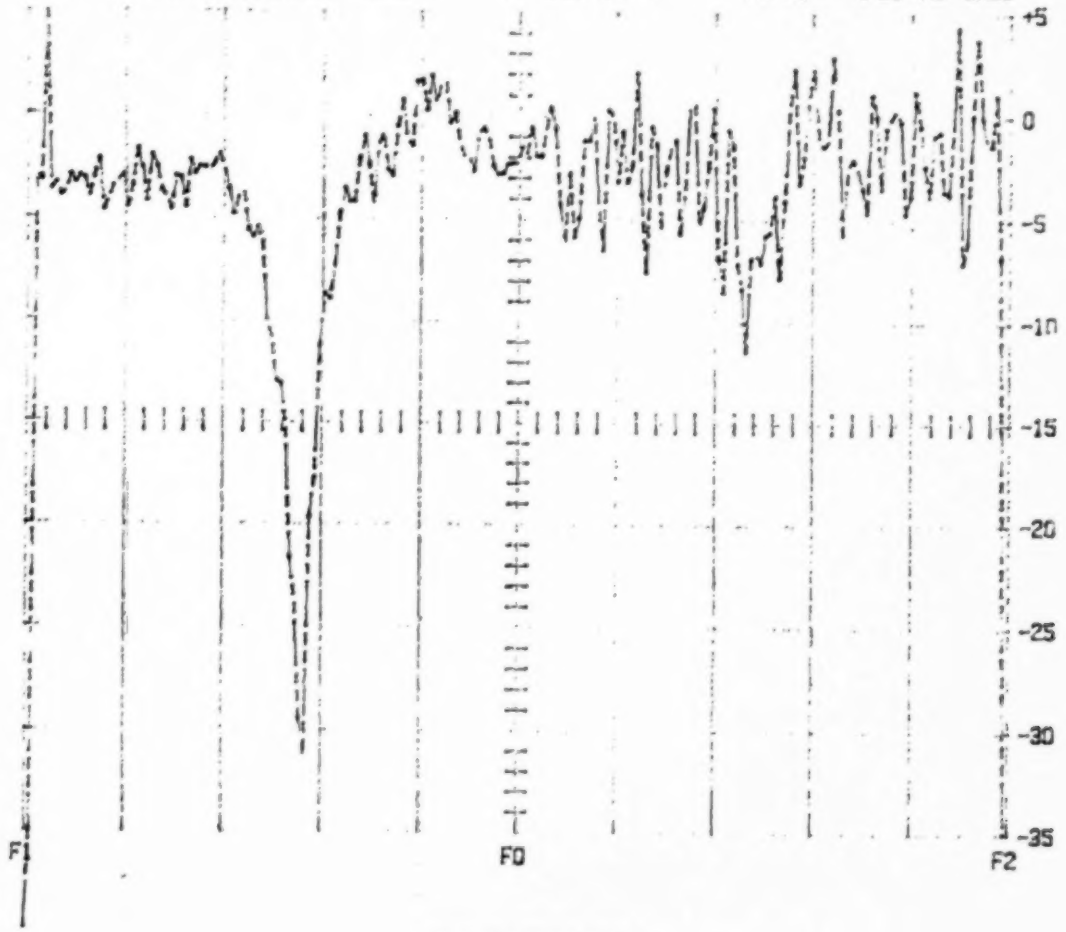
MODEL #: LHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. M.L. =-58.49 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ---------
TRANS. LOSS: ---------

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.7

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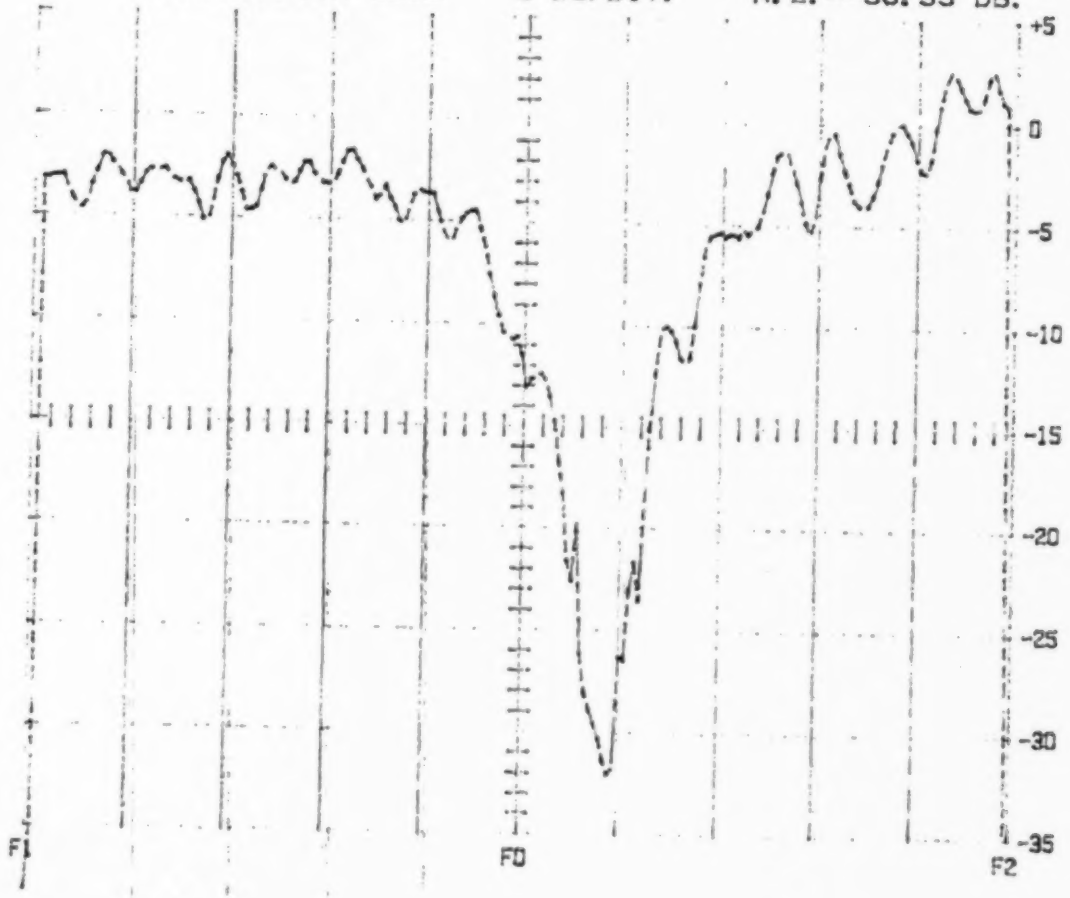
MODEL #: LHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.35 DB.



(DB.)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

(FREQUENCY)

RETURN LOSS: ———
TRANS. LOSS: - - - - -

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.8

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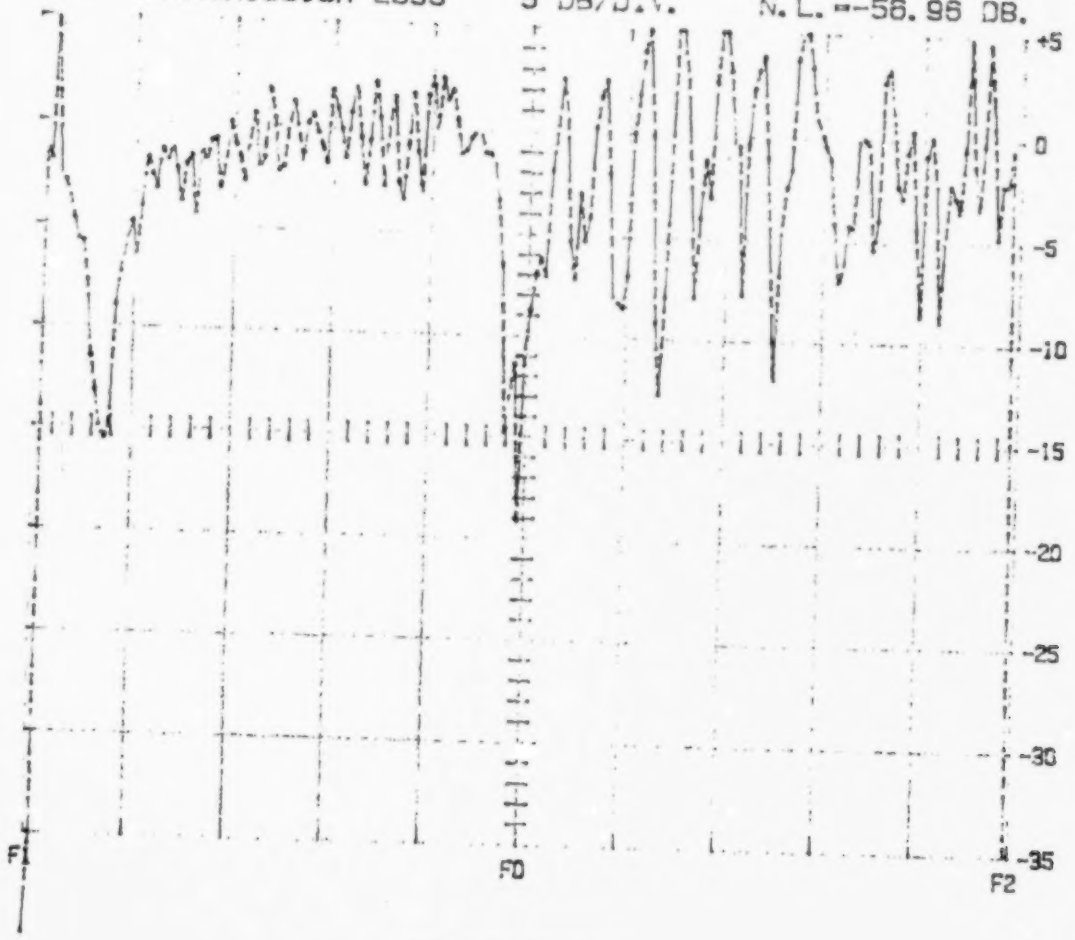
MODEL #: RHCP ATTENUATION DUE TO PS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-56.96 DB.



(DB.)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D. A. T.
APPROVED:

(FREQUENCY)

RETURN LOSS: ————
TRANS. LOSS: - - - - - -

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.9

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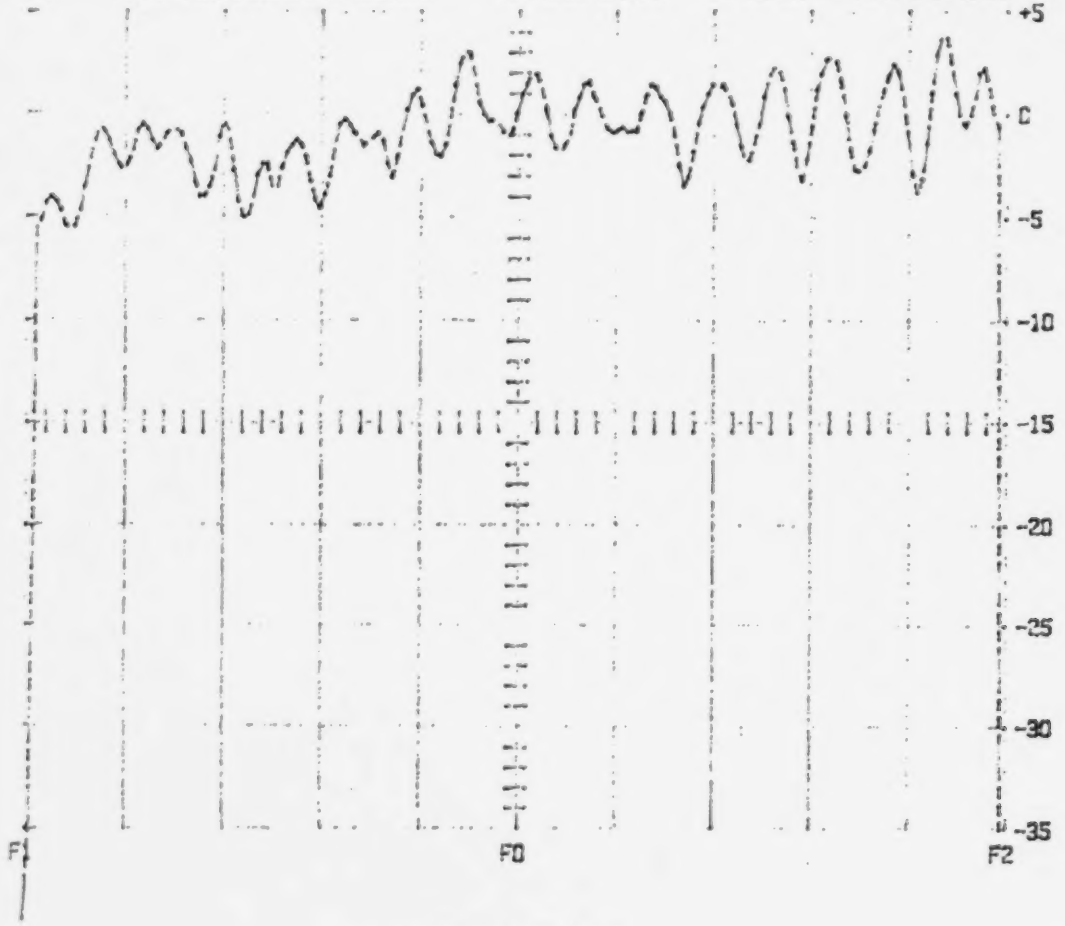
MODEL #: RHCP ATTENUATION DUE TO PSS 0 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-52.56 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - - -

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure A.A.10

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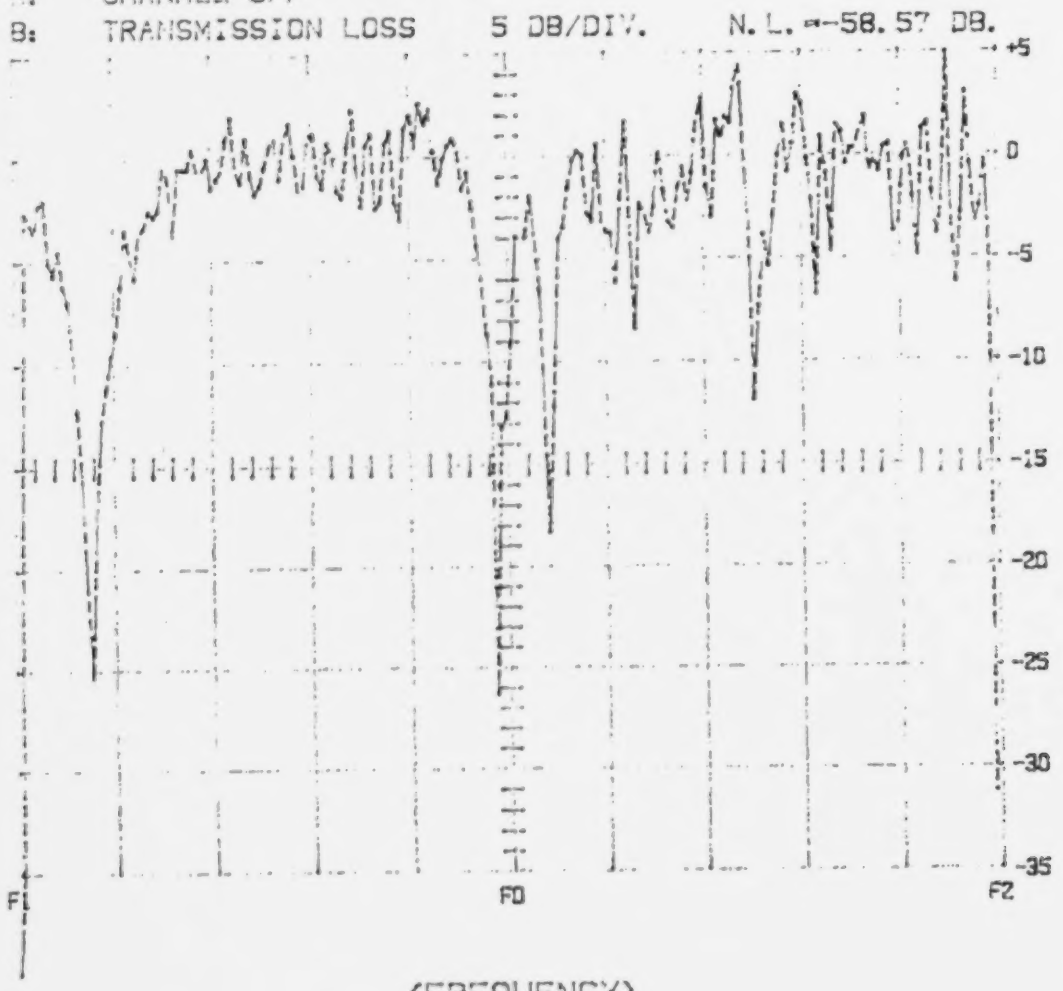
MODEL #: RHCP ATTENUATION DUE TO PSS 15 DEG.



DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: - - - - -

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.11

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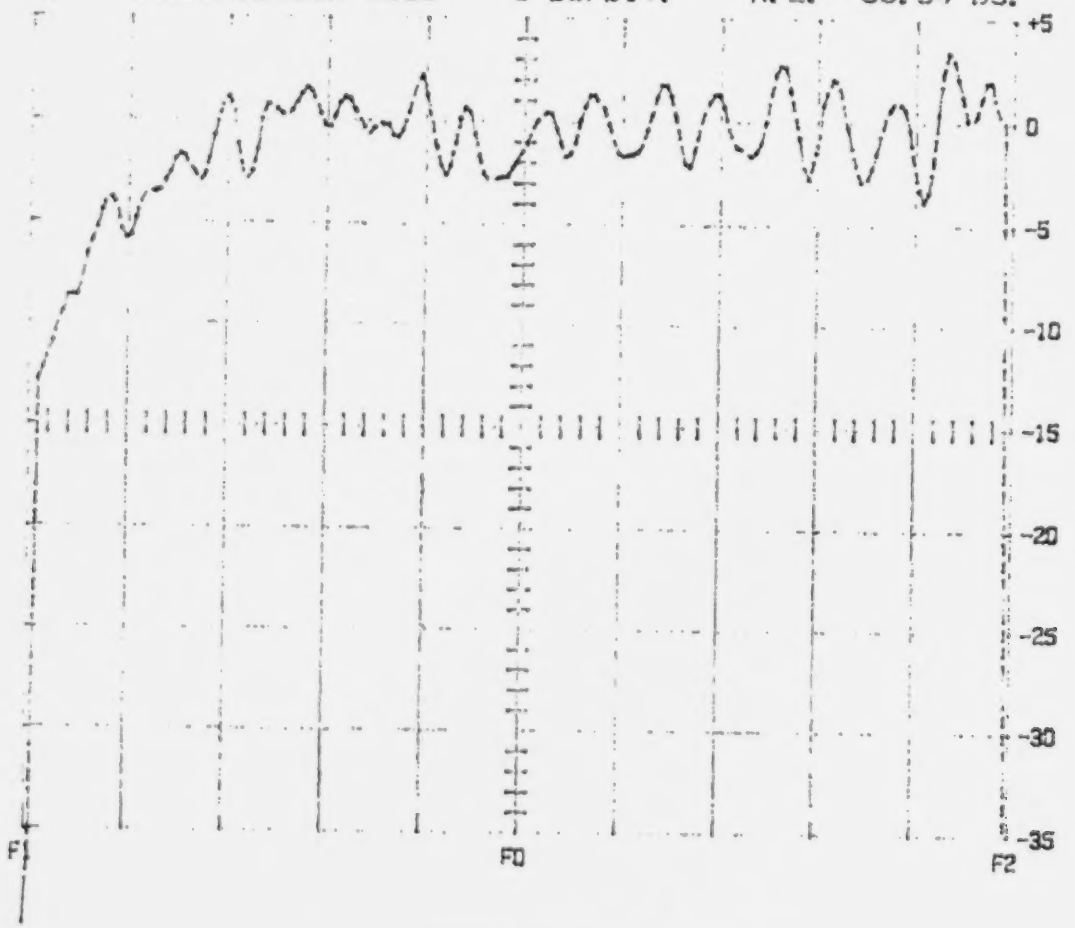
MODEL #: RHCP ATTENUATION DUE TO PSS 15 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. M.L. =-56.54 DB.



DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ------
TRANS. LOSS: ------

FC : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.12

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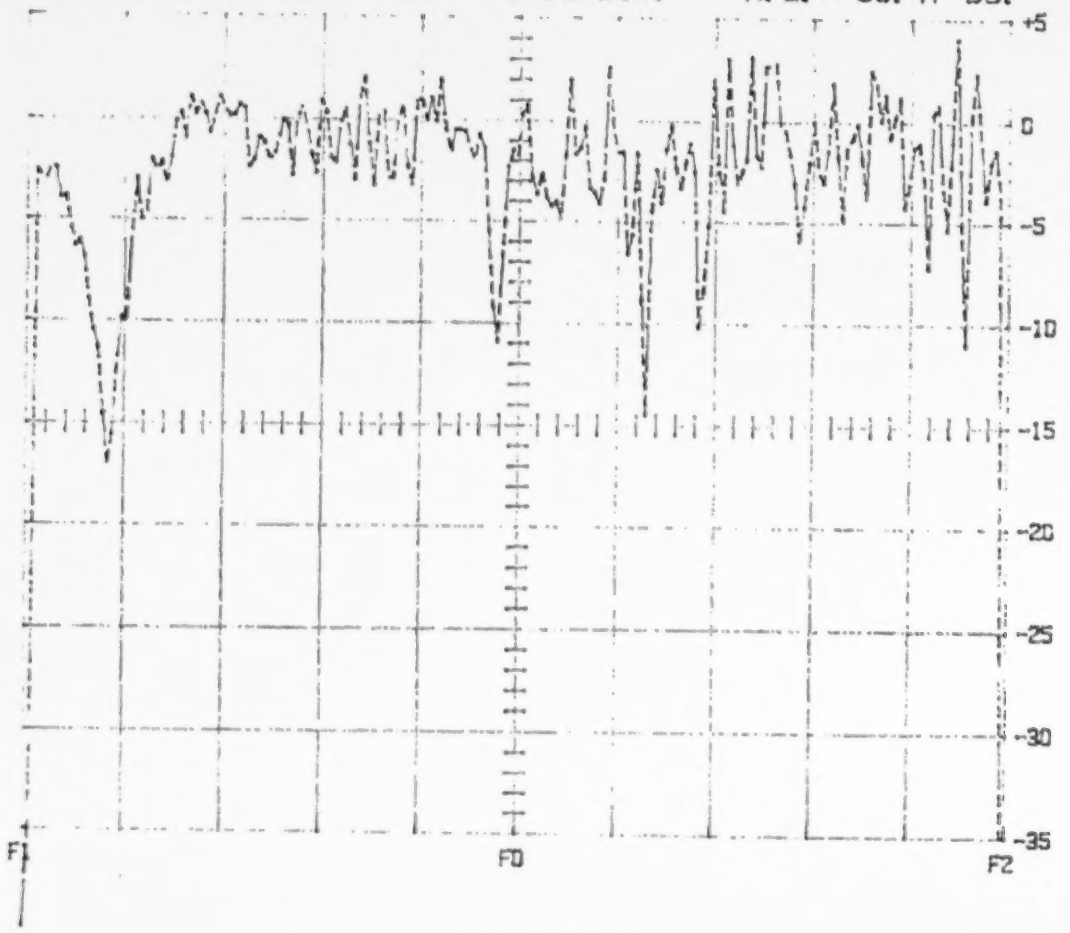
MODEL #: RHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.47 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ----------
TRANS. LOSS: ----------

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.13

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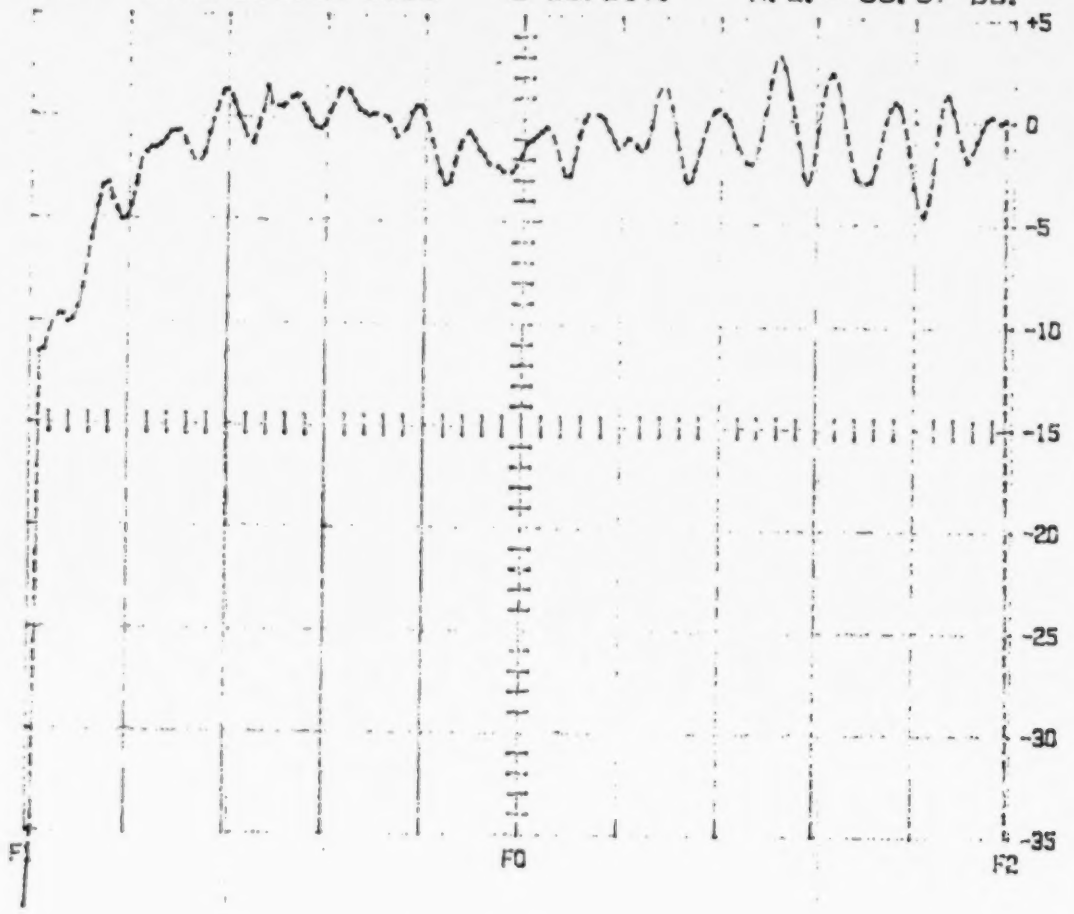
MODEL #: RHCP ATTENUATION DUE TO PSS 30 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. N.L.=-58.67 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: - - - - - -

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL. : 11 DBM.

Figure 4.4.14

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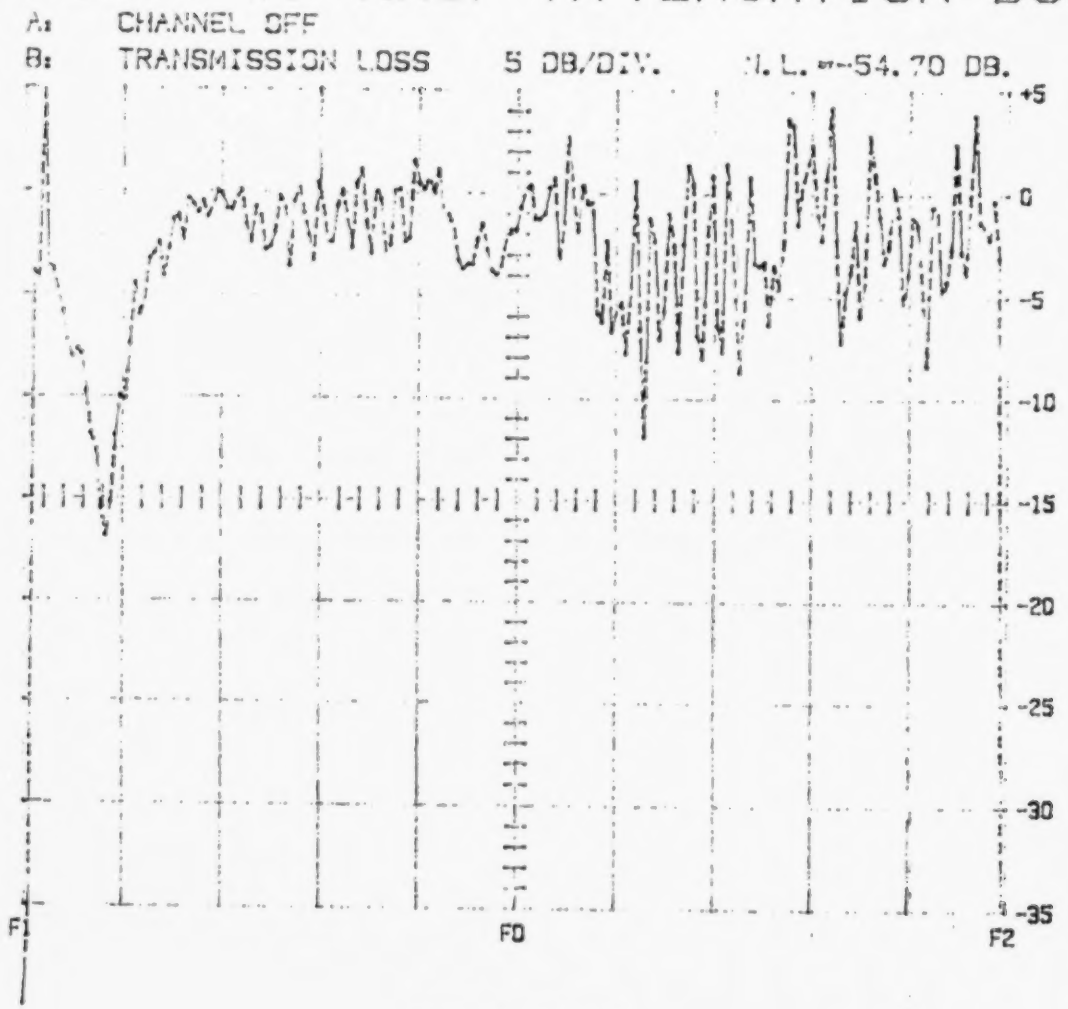
MODEL #: RHCP ATTENUATION DUETO PSS 45 DEG.



DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ———
TRANS. LOSS: - - - - -

F0 : 22500 MHZ.
F1 : 7500 MHZ.
F2 : 37500 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.15

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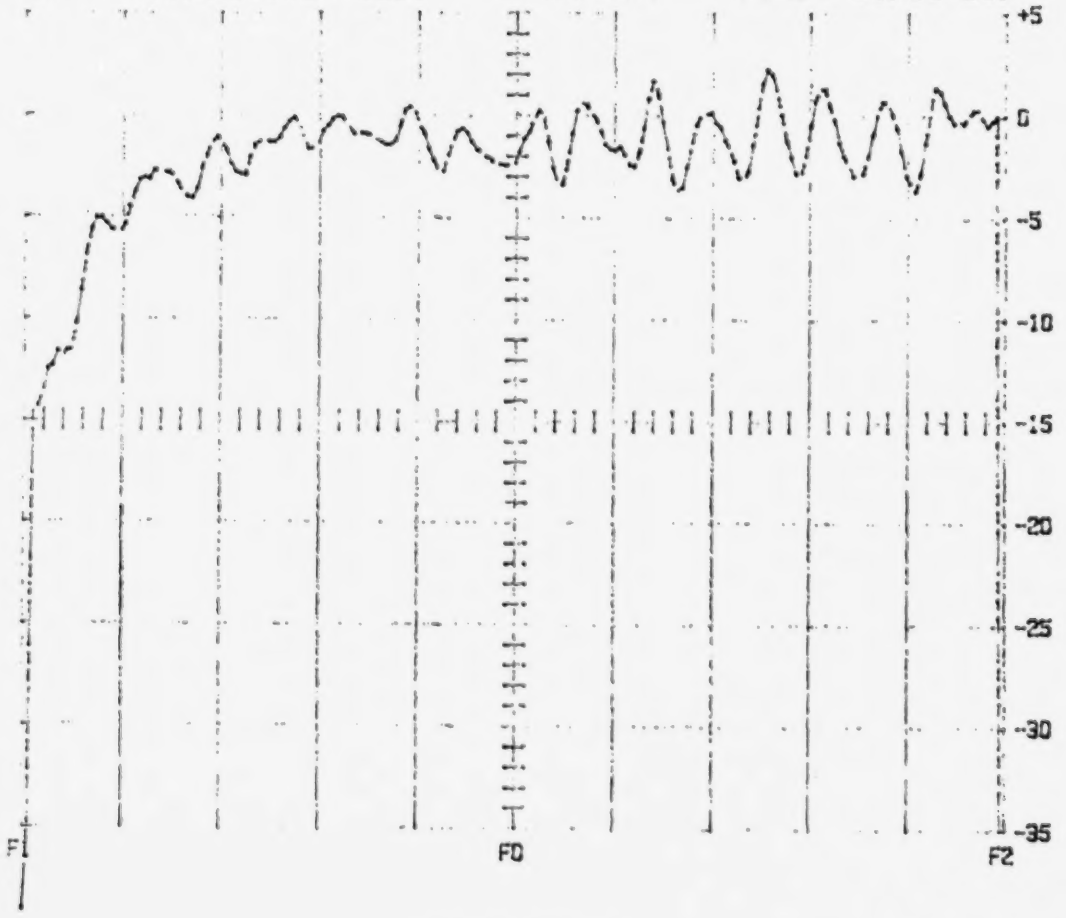
MODEL #: RHCP ATTENUATION DUE TO PSS 45 DEG.

A: CHANNEL OFF
B: TRANSMISSION LOSS 5 DB/DIV. M.L. =-58.35 DB.



(DB.)

(FREQUENCY)

DATE: 29-09-89
SERIAL #: N/A
TESTED BY: D.A.T.
APPROVED:

RETURN LOSS: ————
TRANS. LOSS: - - - - - -

F0 : 15000 MHZ.
F1 : 10000 MHZ.
F2 : 20000 MHZ.

M1 :
M2 :

POWER LEVEL : 11 DBM.

Figure 4.4.16

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2. Dr. Y.L. Chow, "Analytical Study of a 20 GHz Circular Polarization Selective Surface" University of Waterloo, Final Report SSC File No. 06SS.W7714-8-5652, Contract no. W7714-8-5652/01-SS, Nov. 1989

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PERSONAL AUTHOR: Tilston, D.a.; Towne, J.
CORPORATE AUTHOR: Til-Tek Ltd, Kemptville ONT (CAN);Defence Research Establishment Ottawa, Ottawa ONT (CAN)

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IDENTIFIERS: (U) CPSS (Circular Polarization Selective Surface);Reflector antennas

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